The AMSAT® Journal

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Ed Long, WA4SWJ

Assistant Editor:
Bill Hook, W3QBC

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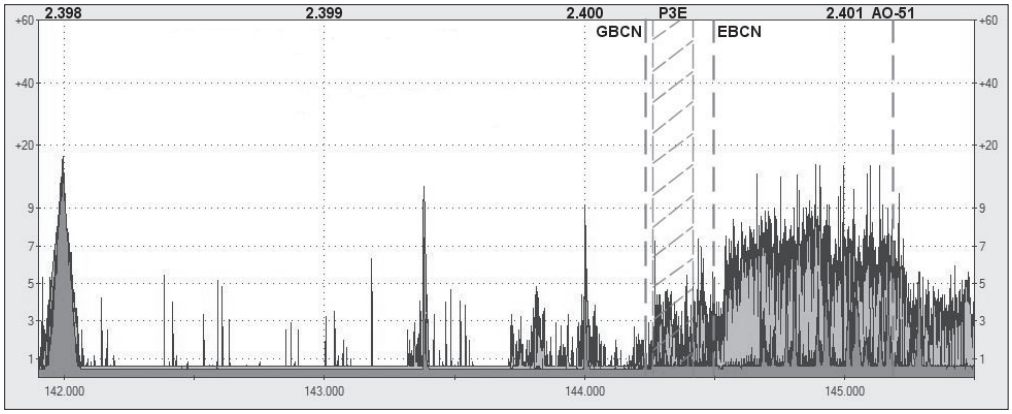

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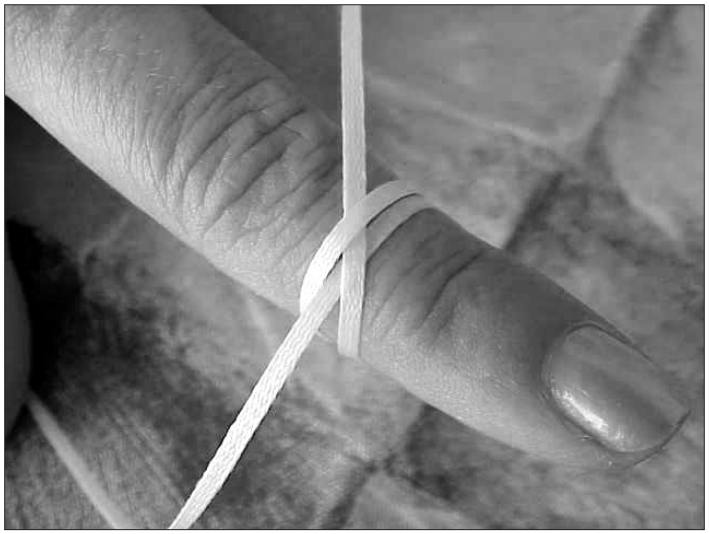

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AMSAT Announcements

BoD Election

As a result of the 2007 board of directors election, WD4ASW, W2GPS, W8GSM and KO4MA will serve on the board for two years. The first alternate is KU4OS. The results of the voting are (871 ballots cast):

Barry Baines, WD4ASW	755
Richard Hambly, W2GPS	735
Gunther Meisse, W8GSM	677
Drew Glasbrenner, KO4MA	608
Lee McLamb, KU4OS	491

Submitted by:

Martha Saragovitz
AMSAT Manager

Note

If you have reached 70-1/2 years of age and have an IRA, you can donate to AMSAT. You may contribute the money you must withdraw each year to a 501(c)(3) charity such as AMSAT. The withdrawal is not counted as taxable income if if goes directly to a charity by an MRD, for example, and does not pass through your hands or bank account. Contact your tax advisor for information. This is the last year this will be available.

AMSAT's Mission

AMSAT is a non-profit volunteer organization which designs, builds and operates experimental satellites and promotes space education. We work in partnership with government, industry, educational institutions and fellow Amateur Radio societies. We encourage technical and scientific innovation, and promote the training and development of skilled satellite and ground system designers and operators.

AMSAT's Vision

Our Vision is to deploy high earth orbit satellite systems that offer daily coverage by 2009 and continuous coverage by 2012. AMSAT will continue active participation in human space missions and support a stream of LEO satellites developed in cooperation with the educational community and other amateur satellite groups.

Radio Amateur Satellite Corporation (AMSAT-NA)
850 Sligo Ave., Silver Spring, MD 20910-4703
Telephone: 301-589-6062 – Toll Free: 888-322-6728
Facsimile: 301-608-3410
AMSAT-NA Club Callsign: W3ZM
AMSAT-NA Web site: http://www.amsat.org

The AMSAT Journal Staff

Editor-in-Chief: Ed Long, WA4SWJ, *wa4swj@amsat.org*
Assistant Editor: Bill Hook, W3QBC
Circulation: Martha Saragovitz, *martha@amsat.org*

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Tom Clark, K3IO, k3io@amsat.org
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Editorial Office: Ed Long, WA4SWJ, 6685 Southeast 108th Street, Belleview, FL, 34420-3449. Please e-mail Journal submissions to: *journal@amsat.org*, telephone: 262-374-1349. Advertising Office: AMSAT-NA Headquarters, 850 Sligo Avenue, Suite 600, Silver Spring, MD 20910-4703.

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The AMSAT Journal staff is always interested in article submissions. Whenever possible, submissions should be sent via e-mail to journal@amsat.org using plain text or word processor files; photos or figures in TIF, GIF or JPEG formats. AMSAT-NA reserves the right to select material for *The AMSAT Journal* based on suitability of content and space considerations. The editors of this publication are volunteers giving freely of their talents, time and efforts to produce *The AMSAT Journal*.

2007 AMSAT Space Symposium and Annual Meeting

The 2007 AMSAT Space Symposium and Annual Meeting are now over. It was an exciting conference filled with outstanding presentations and a never-ending flow of great conversations in the hallways, restaurants and bar. As always, I come away from the symposium with a renewed sense of excitement and enthusiasm for the future of AMSAT and the Amateur Satellite Service.

At the Board meeting it was my pleasure to announce the appointment of two AMSAT members to the AMSAT executive team. They are our new VP Marketing, Dan Briner, AB3EN, from Canonsburg, PA and our new Director of Sales, Steve Kenwolf, WH6BSZ, from Elkins, WV.

For those of you who find yourself in awe of what some of our members have accomplished (or with criticisms of what we are doing) I encourage you to step up and make your own contribution to AMSAT. There is room in AMSAT for everyone's contributions through such outlets as Field Operations, the AMSAT Journal, the Web site, the Eagle project team, or by joining one of our executive teams. A good way to do this is to contact the most appropriate executive team member through the links on the Web site at http://www.amsat.org/ (click on "About AMSAT" then "Our Leadership Team").

The Reality of the Future

The message I presented at this year's Annual General Meeting was the following:

- Planned new missions will provide great new services to the ham community but we cannot pay for them.
- No one will pay for more "toys" for us to play with.
- Our missions must excite the funding sources and there are only two categories that will do so.

  EDUCATION

  o AMSAT Institute

  o Phase-IV TDRS-like support of ARISS

  EMERGENCY COMMUNICATIONS

  o Phase-IV Geosynchronous Satellite

  o Advanced Communications Payload

These conclusions come from three years of in-depth investigation into fund raising, launch opportunities, ongoing P3E and Eagle development activities and consultation with AMSAT members both in North America and internationally.

As a result of these conclusions I have begun focusing my attention on two new projects. The first is a Phase IV mission based on the Eagle payloads and a new geosynchronous rideshare opportunity. The second is the establishment of the AMSAT Institute, a "summer camp" for teachers.

Phase IV Payload

Thanks to the watchful eye of AMSAT's Executive VP Lee McLamb, KU4OS, and the assistance of AMSAT member John Klingelhoeffer, WB4LNM, we are now working with Intelsat to find a way for AMSAT to take advantage of the rideshare opportunity that Intelsat has made available. So far this opportunity has only been made available to U.S. Government agencies but AMSAT has submitted a proposal and it is being seriously considered. I caution everyone to keep this in perspective, however. The benefits of a Phase IV payload are substantial but we do not have a contract and until that happens this is just an opportunity, not a fact. In the meantime we must stay the course on our other missions, P3E and Eagle.

The inevitable questions are being asked about this mission. The footprint of an AMSAT Phase IV transponder will be about 1/3 of the Earth under the satellite. Which third of the Earth that will be for our first mission will be based on the timing of when we can have a payload ready and what launches are available soon thereafter. The sub-satellite point could be over the Atlantic, the Pacific or the Americas. We would certainly choose a launch that will cover the continental U.S. at a minimum. It is our plan to prepare more than one payload so that we can cover multiple areas and to link these payloads somehow. Ultimately it could be possible to achieve worldwide coverage.

Apogee View continues on page 9 ...

Learn DSP By Programming Your PC, Part 2

by Richard F. Crow, N2SPI, n2spi@amsat.org
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Introduction

In the previous article in this series, Part 1, the series concept was introduced, a C programming environment was established and additional reading was suggested. In this part, we'll build on Part1 to write a C program to generate sine wave signal samples, from 20 Hz to 20 KHz in 1 Hz steps and output them. If you have speakers connected to your computer you'll hear the result. In other words, this exercise will show you how to create signal samples and output them through the DAC (Digital to Analog Converter) in the PC's sound card. Before continuing, it's strongly recommended you read Part 1 in the July/August 2007 *AMSAT Journal*. Since program listings will consume most of this part, leaving little room for discussion, we'll focus exclusively on writing software.

Step1: Make New Folders

Right now, boot up your PC, open a DOS window and navigate to c:\dm849c\dm\bin. Then, use the DOS command "md" to make a new subdirectory (folder) named "D2A". Now, navigate to this new subdirectory (c:\dm849c\dm\bin\D2A) and make five more subdirectories named "stage1", "stage2", stage3", "stage4", and "stage5". This will allow you to create d2a.c in 5 stages, one stage at a time. This way, you can type, compile and run the code a little at a time and, as a result, compiler errors, if any, should be fewer at a time, and also contained within a relatively small section of code.

Step 2: Prepare Make.bat, D2A.RC

Now, copy make.bat from c:\dm849c\dm\Program1 to c:\dm849c\dm\D2A\stage1 and rename it make2.bat. Navigate to ...\D2A\stage1 and edit the make2.bat there by searching for the string "Pgm1" and replacing it with "d2a". When done, make2.bat in ...\D2A\stage1 should look like Figure 1. Also, copy Pgm1.rc from c:\dm849c\dm\bin\Program1 to c:\dm849c\dm\bin\D2A\stage1. Then use the DOS command "ren" or "copy", your choice, to rename Pgm1.rc to d2a.rc. Then search for "Pgm1" and replace it with "d2a". When done, d2a.rc in ...\D2A\stage1 should look like Figure 2.

Step 3: Create D2A.C, Stage 1

Create a new file named d2a.c and type in the code in Figure 3. When done, save it in c:\dm849c\dm\bin\D2A\stage1, run make2.bat, and execute d2a.exe. If everything is OK, you should see a small dialog box that includes a horizontal scrollbar with the thumb (slider button) at its extreme left position. At this point in d2a.c, we've #defined all the constants we'll need, declared global variables, and established WinMain(). WinMain() creates a dialog box for this dialog box application, and in line 040, directs the WinOS's attention to the dialog box's message handling function, DlgProc(). Windows OS is a message-based system. When it detects mouse clicks, etc., inside the dialog box, it calls DlgProc() with its arguments "message", "wParam", and "lParam" set to values that indicate what was detected. Right now though, DlgProc() is an empty shell. Once the code in Figure 3 is working, don't add any more to d2a.c here in stage1. If you run into trouble at a later stage, instead of starting over from scratch, you'll want to copy the good files from here, or from whatever stage was last working, as a starting point for making another go at it.

Step 4: Update D2A.C, Stage 2

Copy make2.bat, d2a.rc, and d2a.c from c:\dm849c\dm\bin\D2A\stage1 to c:\dm849c\dm\bin\D2A\stage2. Navigate to ...\D2A\stage2 and in d2a.c, delete everything between lines 050 and 200. Be sure to keep line 050 and line 200. Now go to Figure 4 and type in the code starting with line 051 and ending with line 085. In addition, enter code starting with line 183 and ending with line 199. (The '|' character in lines 079 and 080 is the upper case of the '\' character.) When you execute d2a.exe now, you should again see a small dialog box with a scrollbar. But this time, the thumb will be at the 5000 Hz position. At this stage in d2a.c, we've started to flesh out DlgProc(). In line 064, a "switch" statement has been added. Now, if a "case", in the statement block from line 065 to line 199, matches the "message" in the switch statement, the code following that "case" will be executed. Most importantly, "case WM_SYSCOMMAND:", on line 184, now provides for proper program termination.

Step 5: Update D2A.C, Stage 3

Copy make2.bat, d2a.rc, and d2a.c from ...\D2A\stage2 to ...\D2A\stage3. This time, add code from Figure 5 to d2a.c starting with line 086 and ending with line 133. Doing this will complete the lengthy initialization going on in "case WM_INITDIALOG:" (line 067). Run d2a.exe this time and you should see the same thing as in stage 2.

Step 6: Update D2A.C, Stage 4

Copy make2.bat, d2a.rc, and d2a.c from ...\D2A\stage3 to ...\D2A\stage4. This time we need to add two functions below line 203 shown in Figure 3. To do this, add the code from Figure 6 to d2a.c starting with line 204 and ending with line 230. Run d2a.exe now, and again you'll see the same as

```
REM Filename:       Make2.bat, version 1.0
REM Description:    Compiles .res resource file from .rc resource script.
REM                 Then, compiles .c source file and links it using the specified options
REM                 NOTE: To make .exe file from source other than d2a.c, change "d2a" in
REM                 lines 9 & 10 to new "name". Name must match for both .rc and .c files.
REM Programmer:     Richard F. Crow, N2SPI, August 29, 2007
echo on
cls
C:\dm849c\dm\bin\rcc d2a.rc -32
C:\dm849c\dm\bin\dmc d2a.c winmm.lib comctl32.lib -mn -WA -L/RC -L/SUBSYSTEM:WINDOWS:4.0
pause
```

Figure 1: Make2.bat for d2a.rc and d2a.c

```
//001) Filename:                          d2a.rc, version 1.0
//002) Description:                       Resource script to make d2a.res resource file
//003)                                    that goes with d2a.c, a pgm that generates sine
//004)                                    wave samples xmitted thru sound card D/A output
//005) Programmer:                        Richard F. Crow, N2SPI, August 29, 2007

                                          //007)(this line reserved)
#define IDC_TEXT1  1000                   //008)(must match same #define in d2a.c)
#define IDC_TEXT2  1001                   //009)(must match same #define in d2a.c)
#define IDC_SCROLL 1002                   //010)(must match same #define in d2a.c)

#include<windows.h>                       //012)(preprocr inserts text in".h"files..
                                          //013)...so pgm gets needed'C'definitions)

d2a_resources DIALOG DISCARDABLE 100, 100, 200, 50

STYLE WS_MINIMIZEBOX | WS_VISIBLE | WS_CAPTION | WS_SYSMENU

CAPTION TEXT("D2A,v1.0: Pgm to Output Signal Samples")

FONT 8, TEXT("MS Sans Serif")

BEGIN
 CTEXT TEXT("Sine Wave Generator"),       IDC_TEXT1,  60,     4,     80,    8
 CTEXT TEXT("Frequency:  5000 Hz"),       IDC_TEXT2,  60,    14,     80,    8
 SCROLLBAR,                               IDC_SCROLL, 10,    28,    180,   12
END
```

Figure 2: d2a.rc

in stage 2. At this point, FillBufferWithSineWaveData() now creates the sine wave samples. In line 210, "iFrequency" (cycles/second) is multiplied by TWO_PI to get frequency (radians/second), which is divided by SAMPLE_RATE (samples/second) to get "wtIncrement" (radians/sample). In line 214, note that "wt" is an angle (radians) which increases steadily in time at the rate of TWO_PI radians per cycle of "iFrequency". Thus, "sin(wt)" produces sinusoidal values from +1 to -1 representing a sinewave with the frequency "iFrequency". These values are then multiplied by 32767 to produce full range, signed 16 bit sine wave signal samples. If this is still confusing to you, see:
http://en.wikipedia.org/wiki/Radian
see:
http://en.wikipedia.org/wiki/Angular_frequency
and see:
http://en.wikipedia.org/wiki/Trigonometry.
As for DigitalSignalProcessing(), it will be replaced with the code for a FIR lowpass filter in Part 3.

Step 7: Finish D2A.C, Stage 5

And finally, copy make2.bat, d2a.rc, and d2a.c from ...\D2A\stage4 to ...\D2A\stage5. Add the code from Figure 7 to d2a.c starting with line 134 and ending with line 182. This completes d2a.c. Compile and run d2a.exe to hear what you have wrought. If nothing is heard, click "Start > All Programs > Accessories > Entertainment > Volume Control". Next, click "Options", click "Properties", select "Playback", be sure "Volume Control" and "Wave" check boxes are checked, and click "OK". Then, drag the sliders for the "Volume Control" and "Wave" up to max, drag "Balance" controls to their center, and make sure "Mute" is not checked. As for d2a.c now, "case MM_WOM_OPEN:" initializes both OutBuffer1 and OutBuffer2 with 5000 Hz sine wave data to produce the initial burst of sound. After that, when either OutBuffer empties, "case MM_WOM_DONE:" refills the appropriate OutBuffer with more sine wave samples. Note that two OutBuffers are used for continuity of output such that one can service the D/A, while the other is being filled with new data. If you have a slow PC, or one that is running many programs simultaneously, you may have to increase BUFFER_SIZE to, say, 8192 or more. This sine wave generator was developed from concepts presented in chapter 22 of reference [3].

References

[1] Petzold, Charles (2000), *Code*, Microsoft Press, Redmond, WA, ISBN 0-7356-0505-X, ISBN 0-7356-1131-9 (paperback).

[2] Zhang, Tony, and Southmayd, John (2000), *Sams Teach Yourself C In 24 Hours*, Sams Publishing, Indianapolis, IN, ISBN 0-672-31861-X.

[3] Petzold, Charles (1999), *Programming Windows, Fifth Edition*, Microsoft Press, Redmond, WA, ISBN 1-57231-995-X.

[4] Smith, Steven W. (1997), *The Scientist and Engineer's Guide To Digital Signal Processing*, California Technical Publishing, P.O. Box 502407, San Diego, CA 92150-2407, "www.DSPguide.com", ISBN 0-9660176-3-3.

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```
//001) Filename:          d2a.c, version 1.0
//002) Description:       A DSP program for Windows XP that generates sine
//003)                    wave signal samples and outputs them through the
//004)                    sound card D/A output to speakers, if attached
//005) Programmer:        Richard F. Crow, N2SPI, August 29, 2007

                                        //007)(this line reserved)
#define IDC_TEXT1  1000                 //008)(must match same #define in d2a.rc)
#define IDC_TEXT2  1001                 //009)(must match same #define in d2a.rc)
#define IDC_SCROLL 1002                 //010)(must match same #define in d2a.rc)

#include<windows.h>                     //012)(preprocr inserts text in".h"files..
#include<math.h>                        //013)...so pgm gets needed'C'definitions)

#define SAMPLE_RATE         44100       //015)("#define" alias NAME for...
#define TWO_PI              6.28318     //016) ...text to replace it)
#define MIN_FREQ            20          //017)
#define INIT_FREQ           5000        //018)
#define MAX_FREQ            20000       //019)(in units of Hz)
#define BUFFER_SIZE         4096        //020)(size in bytes is 2*BUFFER_SIZE )

TCHAR szTemplateName[] = TEXT( "d2a_resources" );    //declare globals
TCHAR szErrorMsg1[] = TEXT( "Allocation of memory failed!" );
TCHAR szErrorMsg2[] = TEXT( "Opening WaveOut device failed!" );

BOOL CALLBACK DlgProc(HWND, UINT, WPARAM, LPARAM); //func prototypes
void FillBufferWithSineWaveData(PSHORT, int );
void DigitalSignalProcessing(PSHORT, PSHORT );
//============================== Line 029 ============================
int WINAPI WinMain(                     //030)WinMain() starts this app:
        HINSTANCE       hInstance,      //031)=a number that identifies
        HINSTANCE       hPrevInstance,  //032).this occurance of this app
        PSTR szCmdLine,                 //033)=ptr @ cmd line text,if any
        int  iCmdShow )                 //034)=init'l window(maxmzd?,etc)
{
   DialogBox(                           //036)create a Dialog Box:
        hInstance,                      //037)="instance"handl 4 this pgm
        szTemplateName,                 //038)=ptr @ Dialog Box resources
        NULL,                           //039)=handl of ownr window(none)
        DlgProc );                      //040)=ptr @ Dialog Box procedure
   return 0;
}                                       //042) ( end of "WinMain()" )
//============================== Line 043 ============================
BOOL CALLBACK DlgProc(                  //044)DlgProc handles WinOS msgs:
        HWND            hwnd,           //045)=handl of window get'g msgs
        UINT            message,        //046)=number that is the message
        WPARAM          wParam,         //047)=1st numbr with msg details
        LPARAM          lParam)         //048)=2nd numbr with msg details
{
                                        //050)======== Line 050 =========

if( (message == WM_SYSCOMMAND) && (wParam == SC_CLOSE) ) // (temp)
EndDialog( hwnd, 0 );                   // (temporary C statements)
            //*** NOTE: other lines between 050 and 200 will be typed in later

                                        //200)======== Line 200 =========
   return FALSE;                        //201)IfGetHere, msgs not handled
}                                       //202) ( end of "DlgProc()" )
//============================== Line 203 ============================
```

Figure 3: d2a.c, stage1

```
                                          //050)======== Line 050 =========
                                          //051)declare local variables:
   static int              iScrollPos;    //052)=integer(for scrollbar pos)
   static HWND             hwndScroll;    //053)=a handle(ID # for scrlbar)
   static PWAVEHDR         pWavOutHdr1;   //054)=pointer to (address of)...
   static PWAVEHDR         pWavOutHdr2;   //055) ...a Wave Hdr structure
   static PSHORT           pOutBuffer1;   //056)=pointer @ 1st WaveOut buff
   static PSHORT           pOutBuffer2;   //057)=pointer @ 2nd WaveOut buff
   static PSHORT           pDataBuffer;   //058)=pointer @ another buffer
   static HWAVEOUT         hWaveOut;      //059)=handl(ID# for WaveOut dev)
   static WAVEFORMATEX     waveformat;    //060)=a WavFormat data structure
   MMRESULT                mmResult;      //061)=numbr(return from mm_func)
   TCHAR                   szBuf[60];     //062)=buffr(for setting up text)

switch(message)                           //064)(if match between"messag"..
   {                                      //065)..& "case...",execute case)

   case WM_INITDIALOG:                    //067)msg when dialog box created
      iScrollPos = INIT_FREQ;
      hwndScroll = GetDlgItem( hwnd, IDC_SCROLL );
      SetScrollRange( hwndScroll, SB_CTL, MIN_FREQ, MAX_FREQ, FALSE);
      SetScrollPos(   hwndScroll, SB_CTL, INIT_FREQ, TRUE );

      pWavOutHdr1 = (PWAVEHDR)malloc( sizeof(WAVEHDR) );    //allocate.
      pWavOutHdr2 = (PWAVEHDR)malloc( sizeof(WAVEHDR) );    //...memory
      pOutBuffer1 =  (PSHORT)malloc( 2 * BUFFER_SIZE );     //(InBytes)
      pOutBuffer2 = (PSHORT)malloc( 2 * BUFFER_SIZE );
      pDataBuffer = (PSHORT)malloc( 2 * BUFFER_SIZE );


      if(!pWavOutHdr1 | !pWavOutHdr2 | !pOutBuffer1 | !pOutBuffer2 | !pDataBuffer)
      {                                   //081) if find errors...
         MessageBox( NULL, szErrorMsg1, NULL, MB_OK );
         return FALSE;
      }
                                          //085)======== Line 085 =========

// *** NOTE: lines between 085 and 183 will be typed in later ***

                                          //183)======== Line 183 =========
   case WM_SYSCOMMAND:                    //184)msg when WinOS system event
      if( wParam == SC_CLOSE )            //185)if get sub-message that...
      {                                   //186)...dialog is closing, then
         waveOutReset( hWaveOut );        //187)stop WaveOut device output
         waveOutClose( hWaveOut );
         waveOutUnprepareHeader(hWaveOut, pWavOutHdr1, sizeof(WAVEHDR));
         waveOutUnprepareHeader(hWaveOut, pWavOutHdr2, sizeof(WAVEHDR));
         free( pWavOutHdr1 );
         free( pWavOutHdr2 );             //192)release allocated memory
         free( pOutBuffer1 );             //193)release allocated memory
         free( pOutBuffer2 );             //194)release allocated memory
         free( pDataBuffer );             //195)release allocated memory
         EndDialog( hwnd, 0 );            //196)end dialog
         return TRUE;                     //197)quit"DlgProc" & return TRUE
      }
   }                                      //199)(end of"switch(message){}")
                                          //200)======== Line 200 =========
```

Figure 4: d2a.c, stage2

```
                                                    //085)======== Line 085 =========
      waveformat.wFormatTag = WAVE_FORMAT_PCM;
      waveformat.nChannels = 1;
      waveformat.nSamplesPerSec = SAMPLE_RATE;
      waveformat.nAvgBytesPerSec = SAMPLE_RATE;
      waveformat.nBlockAlign = 2;
      waveformat.wBitsPerSample = 16;               // set wave audio preferences
      waveformat.cbSize = 0;

      mmResult = waveOutOpen(                       //094)open waveOut audio device:
               &hWaveOut,                           //095)=handl of dev actualy opend
               WAVE_MAPPER,                         //096)=select dev(type) to open
               &waveformat,                         //097)=pointer to "waveformat"
               (DWORD)hwnd,                         //098)=inThisCase,dialg box handl
               0,                                   //099)=(function arg not used)
               CALLBACK_WINDOW );                   //100)=flags for opening the dev

      if(mmResult != MMSYSERR_NOERROR)              // if find errors...
      {
         MessageBox( NULL, szErrorMsg2, NULL, MB_OK );
         return FALSE;
      }

      pWavOutHdr1->lpData = (PSTR)pOutBuffer1;
      pWavOutHdr1->dwBufferLength = ( 2 * BUFFER_SIZE );
      pWavOutHdr1->dwBytesRecorded = 0;
      pWavOutHdr1->dwUser = 0;                      // setup "WaveOutHdr1" to..
      pWavOutHdr1->dwFlags = 0;                     // ...describe "OutBuffer1"
      pWavOutHdr1->dwLoops = 1;
      pWavOutHdr1->lpNext = NULL;
      pWavOutHdr1->reserved = 0;

      waveOutPrepareHeader(                         //117)prepare "pWavOutHdr1":
               hWaveOut,                            //118)=handle of waveOut device
               pWavOutHdr1,                         //119)=pointer to headr structure
               sizeof(WAVEHDR) );                   //120)=size of header structure

      pWavOutHdr2->lpData = (PSTR)pOutBuffer2;
      pWavOutHdr2->dwBufferLength = ( 2 * BUFFER_SIZE );
      pWavOutHdr2->dwBytesRecorded = 0;
      pWavOutHdr2->dwUser = 0;                      // setup "WaveOutHdr2" to..
      pWavOutHdr2->dwFlags = 0;                     // ...describe "OutBuffer2"
      pWavOutHdr2->dwLoops = 1;
      pWavOutHdr2->lpNext = NULL;
      pWavOutHdr2->reserved = 0;

      waveOutPrepareHeader(hWaveOut, pWavOutHdr2, sizeof(WAVEHDR) );
      return FALSE;
                                                    //133)======== Line 133 =========

// *** NOTE: lines between 133 and 183 will be typed in later ***

                                                    //183)======== Line 183 =========
```

Figure 5: d2a.c, stage3

```
//============================== Line 203 ==========================
void FillBufferWithSineWaveData( PSHORT pBuffer, int iFrequency )
{
   static float wt;                              //206)(note: "wt" = "Omega_t"...
   float wtIncrement;                            //207)..i.e.(radianFreq * time) )
   int i;                                        //208)variable 4 indexing pBuffer

   wtIncrement = ( (TWO_PI * (float)iFrequency) / SAMPLE_RATE );

   for(i=0 ; i<BUFFER_SIZE ; i++)                //212)loop to fill buff w/samples
   {
      pBuffer[i] = (SHORT)( 32767.0 * sin( (double)wt ) );

      wt = wt + wtIncrement;                     //216)add radians/sampl increment
      if( wt > TWO_PI )                          //217)if wt exceeds TWO_PI...
         wt = wt - TWO_PI;                       //218)...subtract TWO_PI from it
   }
}                                                //220( end of "FillBuffer...()" )
//============================== Line 221 ==========================
void DigitalSignalProcessing( PSHORT pIn, PSHORT pOut )
{
   int i;                                        //224)(note: AtThisTime,this is..
                                                 //225)..a dummy "pass-thru" func)
   for(i=0 ; i<BUFFER_SIZE ; i++)
      pOut[i] = pIn[i];                          //227)copy "InBuf" to "OutBuf"
}                                                //228)(end of "DigitalSig...()" )
//============================== Line 229 ==========================
// end of program
```

Figure 6: d2a.c, stage 4

Apogee View - continued from page 3.

AMSAT Institute

The AMSAT Institute is an opportunity for teachers and others to spend some time every summer at the AMSAT lab and the nearby University of Maryland Eastern Shore (UMES) campus. This project is in its infancy but the university and the Hawk Institute for Space Sciences (HISS), with whom we share the lab space, are signed up, in principal, to participate. The idea is to teach teachers so they can carry back to their students around the world the experiences they gain from spending time with us. There would be a balance of both classroom and lab instruction provided by AMSAT, UMES and HISS staff. I hope we can get accreditation for Continuing Education Units (CEUs) and funding to offset the costs for the teachers as well as AMSAT.

If you think you can assist with development of this project, creation of the curriculum, staffing the Institute, teaching courses or in any way, please contact AMSAT's Executive VP Lee McLamb, KU4OS, or his team member, Director of Education Paul Shuch, N6TX. You can e-mail them at their call sign at amsat.org.

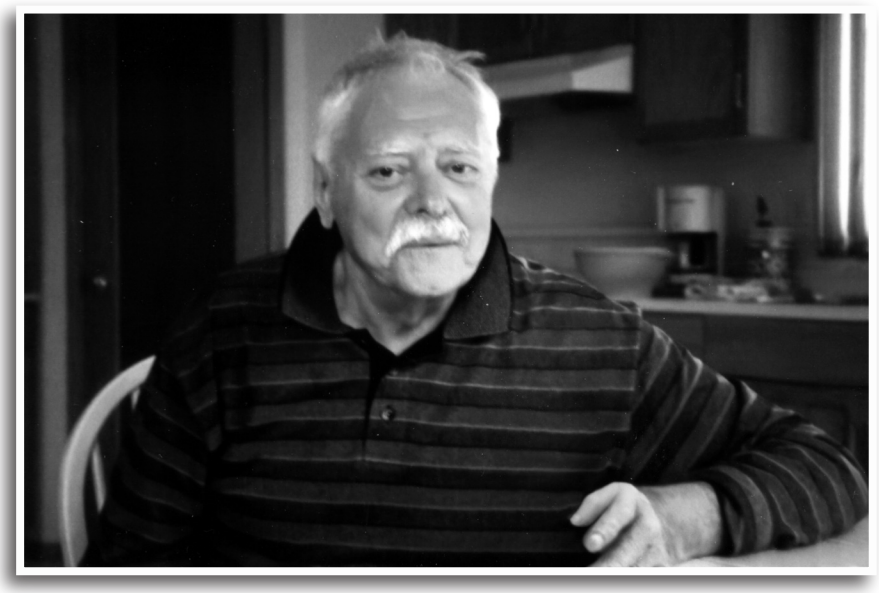
Summary

AMSAT has spent the past few years preparing itself to implement the missions of the future. This year will focus on measurable results in all areas of the organization. AMSAT needs the support of our membership, including your feedback, your donations and your participation in AMSAT activities.

73,
Richard M. Hambly, W2GPS
AMSAT President

VE4MX - SK

AMSAT notes with sadness the passing of Fred Zeltins, VE4MX, AMSAT member number 32722. Fred was a long time member of AMSAT and generously bequeathed $1000 to AMSAT from his estate. Fred will be missed and AMSAT offers our most sincere condolences to Fred's family and friends.



```
                                          //133)======== Line 133 =========
case MM_WOM_OPEN:                         //134)msg when WaveOut dev opened
   FillBufferWithSineWaveData( pOutBuffer1, INIT_FREQ );
   waveOutWrite( hWaveOut, pWavOutHdr1, sizeof(WAVEHDR) );
   FillBufferWithSineWaveData( pOutBuffer2, INIT_FREQ );
   waveOutWrite( hWaveOut, pWavOutHdr2, sizeof(WAVEHDR) );
   return TRUE;

case MM_WOM_DONE:                         //141)msg when an"OutBuf"is empty
   if( ((PWAVEHDR)lParam)->lpData == (PSTR)pOutBuffer1 )
   {                                      //if"OutBuf1"empty...
      FillBufferWithSineWaveData( pDataBuffer, iScrollPos );
      DigitalSignalProcessing( pDataBuffer, pOutBuffer1 );
      waveOutWrite( hWaveOut, pWavOutHdr1, sizeof(WAVEHDR) );
   }
   else                                   //148)else,"OutBuf2" empty, so...
   {                                      //149) ...refill it & send it out
      FillBufferWithSineWaveData( pDataBuffer, iScrollPos );
      DigitalSignalProcessing( pDataBuffer, pOutBuffer2 );
      waveOutWrite( hWaveOut, pWavOutHdr2, sizeof(WAVEHDR) );
   }
   return TRUE;

case WM_HSCROLL:                          //156)msg when scrollbar is moved
   switch(LOWORD(wParam))                 //157)("TypeOfMovement"in wParam)
   {                                      //158)(note:"Freq" = "ScrollPos")
   case SB_LINELEFT:                      // 4 left scrlbar arrow button
      iScrollPos = iScrollPos - 1;        // decrement "ScrollPos" by  1
      break;
   case SB_LINERIGHT:                     // 4 right scrlbar arrowbutton
      iScrollPos = iScrollPos + 1;        // increment "ScrollPos" by  1
      break;
   case SB_PAGELEFT:                      // for paging scrollbar left
      iScrollPos = iScrollPos - 20;       // decrement "ScrollPos" by 20
      break;
   case SB_PAGERIGHT:                     // for paging scrollbar right
      iScrollPos = iScrollPos + 20;       // increment "ScrollPos" by 20
      break;
   case SB_THUMBPOSITION:                 // 4 dragging scrollbar"thumb"
      iScrollPos = HIWORD(wParam);        // update when mouse released
      break;
   }
   if( iScrollPos < MIN_FREQ )            //175)if "pos" below MIN_FREQ...
      iScrollPos = MIN_FREQ;              //176) ...jam it to MIN_FREQ
   if( iScrollPos > MAX_FREQ )            //177)if "pos" above MAX_FREQ...
      iScrollPos = MAX_FREQ;
   SetScrollPos( hwndScroll, SB_CTL, iScrollPos, TRUE );
   wsprintf( szBuf, TEXT(" Frequency: %5d Hz "), iScrollPos );
   SetDlgItemText( hwnd, IDC_TEXT2, szBuf );
   return TRUE;
                                          //183)======== Line 183 =========
```

Figure 7: d2a.c, stage 5

Increased Amateur Satellite Service 2 Meter Usage

A Discussion Paper by Graham Shirville, G3VZV, g.shirville@btinternet.com
IARU Region 1 Satellite Co-ordinator

This paper is based on one that was presented at the IARU Region 1 Interim meeting in Vienna earlier this year.

During the meeting it was noted that the existing EME exclusive 144.00 -144.036 MHz worldwide "allocation" is no longer generally used due to QRM from computers and due to the now almost universal use of machine generated modes rather than CW for this activity. Other than the satellite allocation, 145.80-146.00 MHz, this part of the band is the only worldwide standard.

It is also noted that, currently, in the US (?) and Canada (?) there is a license condition restricting amateurs to transmit only CW in the 144.00-144.10 MHz part of the band. It is not clear how important this would be in "restricting" their reception of SSB from satellites or in restricting the licensing of any American satellites themselves (It is reported that ARRL has recently petitioned the FCC to amend this rule to transmissions having a maximum bandwidth of 200Hz, RM-11306)

The IARU Region 1 Interim meeting resolution is quoted below:

Action point for the Satellite Coordinator: To review today's discussions, to analyse information from the other regions, and to consider submitting a further paper at the follow-up conference, including full justification for the need to act.

Current Use

The Amateur Satellite Service has, according to ITU decisions, access to the full allocation of 144-146MHz but, by agreement of all three IARU Regions, currently only uses a section of the allocation on an exclusive basis - namely 145.80 – 146.00 MHz. It is used for both for satellite uplinks and downlinks. It is the most popular of the amateur satellite allocations for the following reasons:

- It is the only band between 30 MHz and 24 GHz that we have primary use and hence some control. The 435 MHz, 1.26, 2.4, 5.6, 5.8, and 10 GHz bands are all shared with either high power users (radars) or large numbers of consumer devices which raise the noise floor.
- 144 MHz is the best band for amateur satellite downlinks due to ease of on board RF power generation and efficiency thereof and the reduced path losses.
- Receiving equipment is widely available. This is an important consideration in many countries where amateur satellites are seen as an important tool in encouraging young people to pursue technical self-training.
- Ready availability of launch opportunities where size constraints mean attitude control is often not possible. The lack of attitude control mandates the use of simple omni-directional antennas. This in turn means the use of VHF due to the lower path losses.

Although, in theory, our primary status should prevent this, there has been a dramatic increase in levels of unlicensed usage in the 2-meter band in a large number of countries in ALL IARU regions. It is therefore apparent that we should start to use 144.800 – 146.000 primarily for downlinks to overcome the interference that is caused to uplinks. This part of the 2-meter band is presently quite heavily used by amateur satellites. In addition, on the International Space Station, there is an amateur packet repeater and voice operations from the amateurs onboard are also taking place in this narrow segment.

Future Use Requirements

An area that has been growing rapidly has been the development of amateur satellites by university students. Already large numbers of students have been involved in developing amateur satellites; this growth activity is beneficial to both the students and the wider amateur community. The students of today are becoming our successors and supporters of tomorrow.

About to be launched is a very small (triple CubeSat), university student satellite using a linear transponder for CW/SSB use with a bandwidth of 40-50 kHz. The uplink will be on 435 MHz and the downlink on 144 MHz. It is expected that more of these projects will materialize and developments are also taking place to develop DSP based AGC systems for these transponders to remove the "alligator effect" problem. It is also anticipated that additional and unexpected launch opportunities may occur where this sort of transponder could be quickly/easily incorporated.

There is therefore a need for an additional satellite segment at 144 MHz that could be used for linear transponder downlinks for CW/SSB operation. Given that these transponders might have a bandwidth of perhaps 35 kHz, the use of a segment approximately 45kHz wide would be required to allow for Doppler shift, which can be as great as +/- 3 kHz.

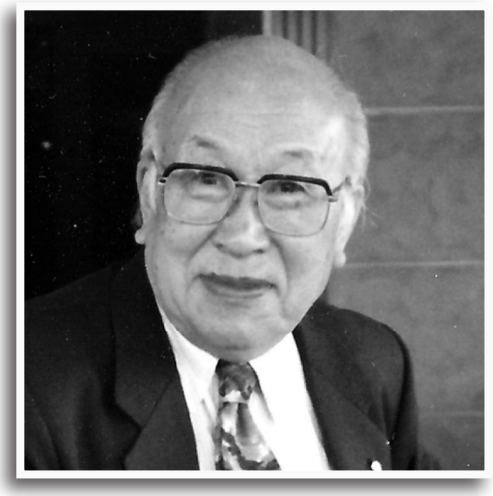
Discussion Points

1. To permit satellites, operating in the Amateur Satellite Service, which incorporate "linear" transponders, which are generally used for narrow band non channelized signals, to use, on a **non exclusive basis**, the section of the 2 meter band 144.005 –144.045MHz for downlink (satellite to ground) mode only, by amending the bandplans in each IARU Region.
2. The presence of interfering non-amateur signals in the 145.80-146.00MHz part of this band, in many parts of the world, is well documented. To prevent the retransmission of interfering terrestrial signals, satellites in the Amateur Satellite Service that plan to use the 2 meter amateur band are encouraged to use this band for downlink (satellite to ground) modes only, regardless of modulation type.

Proposal

These ideas be generally circulated for consideration in the two other IARU regions and a new proposal be presented at the upcoming IARU Region 1 Conference in late 2008 in Croatia.

Please support AMSAT-NA.
Thanks!



JA1ANG in 1996
Photo by Keith Baker, KB1SF

Haruo Yoneda, JA1ANG, 1919 - 2007

Sad news regarding the passing of a long-time AMSAT member and supporter arrived early in October. Tak Okamoto, JA2PKI flashed word that Haruo (Harry as we all called him) Yoneda, JA1ANG, succumbed to pneumonia on Monday, October 8. He was 88.

Many AMSAT members will remember JA1ANG as a regular attendee at AMSAT-NA Annual Meetings and Space Symposia for many years. Back in the 1990s, he was an AMSAT-NA Board member. His support of AMSAT-NA is demonstrated by the fact that he held AMSAT-NA Life Membership Number 14. As well as being an avid supporter of AMSAT-NA, Harry was a co-founder of the Japanese, brother organization, JAMSAT.

Traveling widely in connection with his professional employment with a Tokyo based worldwide advertising agency, Harry Yoneda was particularly effective on the international amateur satellite scene, serving as a link between the various AMSAT groups around the Globe.

Obtaining his first amateur radio license in 1936 as J2NG, Harry became a well known DXer and member of FOC as JA1ANG before being bitten by the satellite bug about the time of Australis OSCAR -5. It was always a pleasure to hear N3AMW on the AMSAT repeater in the Washington area and know that JA1ANG was in in town.

Harry Yoneda attended Case Western University in Cleveland and later received a Masters Degree from Columbia University in New York.

We will all miss Harry's smiling face at our Annual Meetings. He was a great supporter of AMSAT and a good friend.

Bill Tynan, W3XO

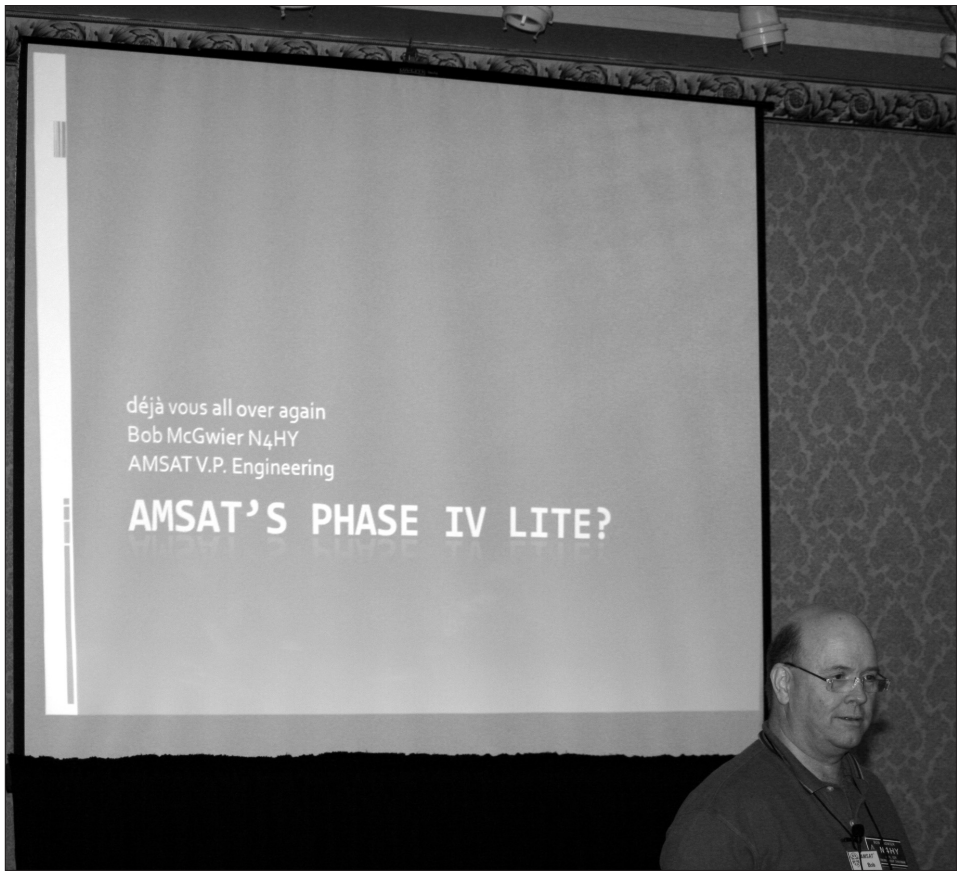
Symposium continued from page 26 ...

base with AMSAT's Field Organization.

In Conclusion

The AMSAT Board of Directors announced that the 2008 AMSAT Space Symposium will be held in October in Atlanta, Georgia. This Symposium will be named the "2008 Harry Yoneda, JA1ANG, AMSAT Space Symposium" in memory and honor of JA1ANG - Silent Key. Harry was a former AMSAT Board Member and close friend of many in the group. Harry also was a founding member of JAMSAT.

In conclusion it was a special weekend. AMSAT's news on new opportunities and the technical discussion charged up everyone who attended. They realized they were there on the weekend that changed Amateur Radio.

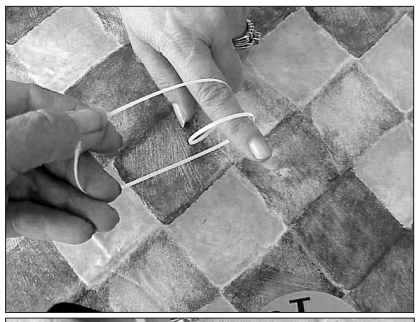


Bob McGwire, N2HY, presents information on Phase IV Lite at the AMSAT Symposium.

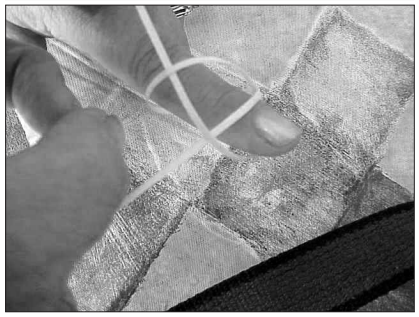
How to Tie a Wire Bundle Using Lacing Cord

by Lou McFadin, W5DID, w5did@amsat.org

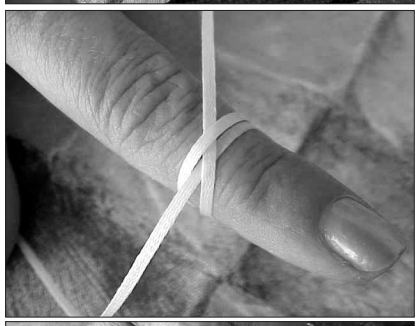
1. Cut off a length of lacing cord long enough to wrap around the bundle at least two times with enough extra so that you can get a good grip on it.



2. Tuck one end over the center turn and under the first part of the turn.

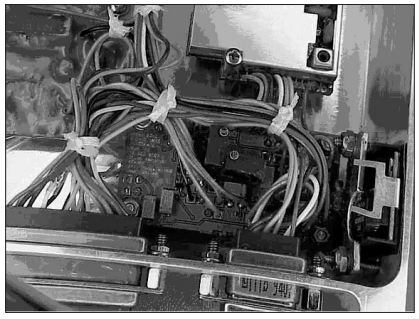


3. Pull the ends to tighten.



4. Then tie the ends in a knot and pull everything tight.

5. Finished ties should look like this.



If you are using the flight lacing cord that has no wax on it, you should fix the knots with a drop of super glue. I always use a hot iron or thermal wire stripper to cut the cord to prevent fraying of the lacing cord.

For flight systems that are concerned about outgassing, the lacing cord in this photo meets all the necessary requirements.

MissionFish

For all of you that sell your goodies on eBay, whether it is ham radio related or not, you can donate a portion of your sale automatically to AMSAT through MissionFish. To do this, when you list your item for sale, there is a tab that pops up on the "How you're selling" screen for Online Auction or Fixed Price. Within those tabs, there is a blue and yellow ribbon with "Donate a percentage of sale." After selecting AMSAT as your nonprofit organization, pick a percentage of the selling price to go to the AMSAT. That's all you have to do. When the auction is over, you give your donation to MissionFish or do nothing and MissionFish will deduct it from your credit card. In turn, MissionFish, will deposit the funds into AMSAT's bank account.

This is an ideal way to donate a little bit or a big bit to AMSAT every time you auction something. You do not need to be a member of AMSAT to donate money through eBay's online auctions. So, ask your non-ham friends if they would donate a little to AMSAT every time they auction something on eBay.

To see how MissionFish works, go to http://www.missionfish.org.

Bruce Paige, KK5DO
AMSAT Online Store Manager

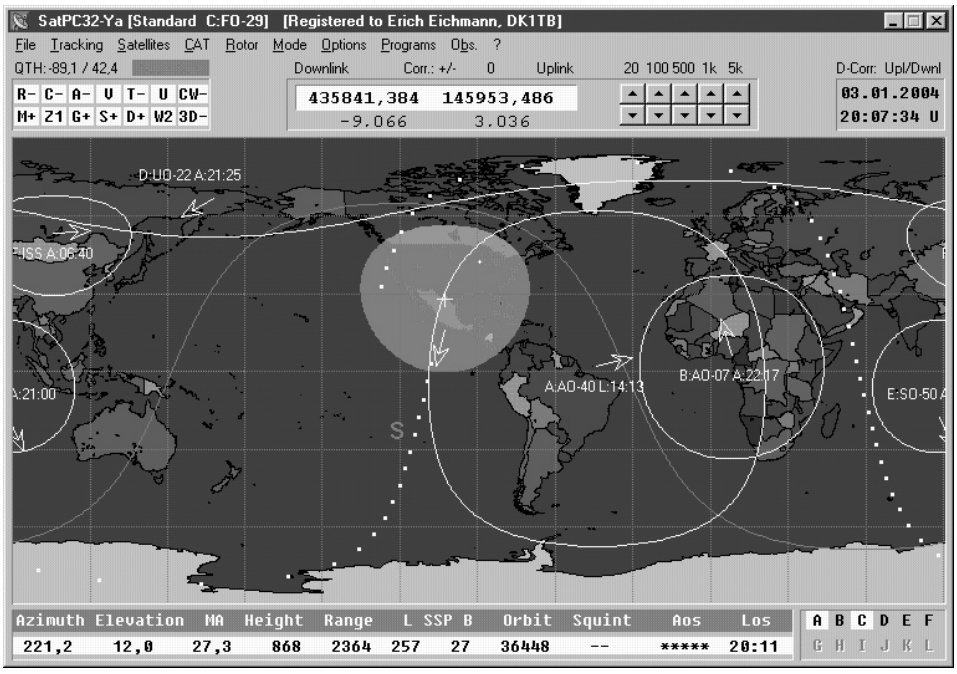
AMSAT is the North American distributor of **SatPC32**, a tracking program designed for ham satellite applications. For Windows 95, 98, NT, ME, 2000, XP.

Version 12.4 now supports Labjack U12 and W0LMD rotor controllers and Doppler tuning for Yaesu FT-817/857/897.

Features:

- Version 12.4 also supports automatic Internet download of Keplerian elements.
- Graphical tracking on a world map with two selectable Zoom factors.
- One-click satellite switching using 12 "letter" buttons.
- Automatic rotor control support for: Kansas City Tracker/Tuner, FODtrack, Uni_Trac, SatEL, Labjack U12/Piggyback, W0LMD Mini/Junior/Senior Trackers, Yaesu GS-232, ARS from EA4TX, EGIS rotors, IF-100, RIF-PC, AMSAT-DL interface, WinRotor32, HalloRotor, and WiSP DDE clients.
- Doppler tuning with on-screen frequency displays. Radio models supported:
  Yaesu FT-847, FT-736R, FT-817, FT-857, FT-897
  ICOM IC-820H, IC-821H, IC-910H and other ICOM radios
  Kenwood TS-790 and TS-2000
  DDE client programs
- "Transparent" VFO-knob tuning in addition to keyboard and mouse tuning.
- "Virtual" VFO tracking for half-duplex transceivers FT-817, FT-857, FT-897.
- Includes a special version for ISS split-frequency operation.
- Controls subaudible tone on FT-847, FT-736R, FT-817/857/897, and IC-910H.
- Includes a non-graphical version and programs that output lists to the screen, printer, or a file.
- Interfaces with WiSP, with user-defined satellite switching priority.
- Includes a separate program for tracking the Sun and Moon.

Price is $45 for AMSAT members, $50 for non-members, on CD-ROM.
A demo version may be downloaded from http://www.dk1tb.de/indexeng.htm
A registration password for the demo version is $40 (members), $45 (non-members).
Order by calling 1-888-322-6728, or use the online shop at www.amsat.org.
The author DK1TB donated SatPC32 to AMSAT. All proceeds support AMSAT.



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- Uses GS-232A or Easycomm I/II protocols

Contact Martha at the AMSAT office 301-589-6062 to order.

The complete units will be built in groups, so get your orders in early.

We expect the enclosures the first of Dec 2007, and should get the first 50 orders out in a timely manner after we receive the enclosures.

1) Bare board with instructions and parts list CD - $20 + S&H – no parts kits available
2) Populated board, serial interface, with CD - $100 + S&H – no kit with USB unit, rotor cable and LCD available, we do have a parts list with recommended part numbers and sources.
3) Custom Ten-Tec Enclosure powder coat, silk-screened, drilled/punched - $50 + S&H
4) Complete unit - board, USB output, rotor cable, LCD, enclosure, serial chip and CD - $200 + S&H **our most popular

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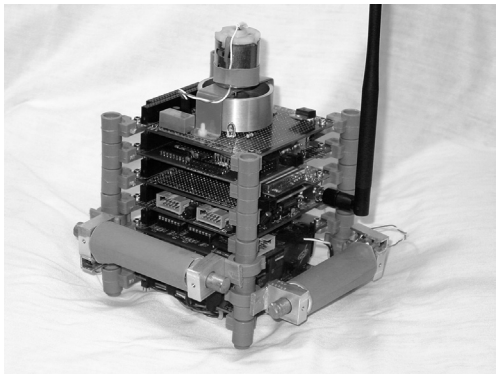

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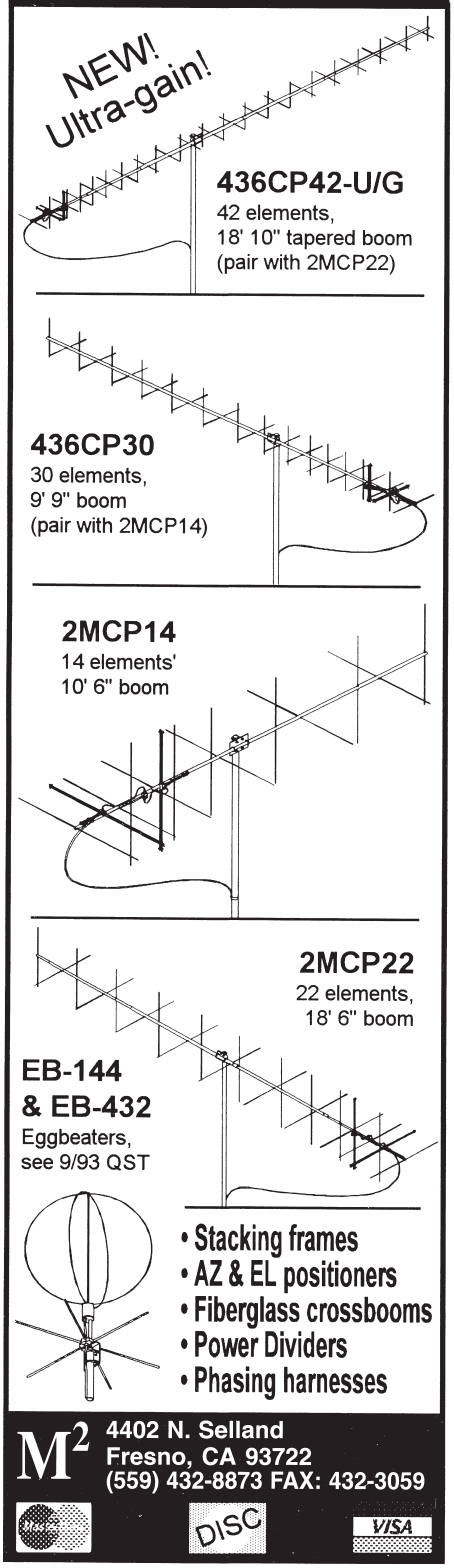

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DISC VISA

The Orbital Classroom, Column #10
ITAR Attacks!

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AMSAT Director of Education

The Orbital Classroom

As radio amateurs, and technologists, and satellite enthusiasts, we inhabit a very different world from that in which our neighbors reside. We tend to view our planet from space, as a fragile blue dot floating in a black void. Our world is unified, devoid of political barriers, a spacecraft we all share, one which, together, we must all preserve. Our neighbors live their lives on flat maps, demarked by national boundaries, with individual political subdivisions set apart from one another by distinctive colors. And herein lies the disconnect.

It is our nature, as radio amateurs, to communicate, to share information, to help one another in the pursuit of our hobby and the pursuit of our lives. Our community is broad, diverse, and rewarding. We share our planet with friends; unfortunately, the rest of the world perceives a planet full of enemies. No matter how hard we try to convert the world over to our viewpoint, we still have to live within the *realities* of their world. One of those realities is that governments create barriers to international cooperation, barriers which often restrict our satellite community's efforts.

The law of the land in the US includes a lengthy provision known as ITAR, for International Traffic in Arms Regulations. Formally consisting of 22 CFR Chapter I Subchapter M Parts 120-130 as amended through 72 FR 31452, ITAR is a litany of legalese now totaling 244 pages. Its stated purpose is to prevent the proliferation of weapons systems. Its sub-purpose is to keep attorneys gainfully employed. Its direct consequence is to stifle international cooperation in many arenas, including the design, construction, launch, and use of amateur satellites.

The intent of ITAR was to preclude the export of weapons systems from the US. As a pacifist, I can hardly argue with this lofty goal. Unfortunately, it has been extended to restrict the distribution beyond our borders of anything that can conceivably be *used* as part of a weapons system. This broad definition clearly applies to electronics hardware, software and designs (that is, just about everything that goes into our satellites). Further complicating our job as AMSAT educators is the fact that ITAR restrictions apply to information, not just material goods. So, I cannot train foreign students in ITAR-restricted technologies, or allow them to work in the university lab where one of our satellites might be under construction or testing! In other words, ITAR would have us all check citizenship papers before allowing the world's radio amateurs to collaborate in our space endeavors. Clearly, these are policies in direct conflict with hams' worldview.

One work-around is to employ only technologies that are already generally available worldwide (and to carefully document this fact). Such an approach would preclude design innovation, restricting us from using the latest and greatest in components, circuits, software, or architecture. A powerful example (pun fully intended) is solar electric generation. Under ITAR, we might be precluded from employing on our satellites the latest in triple-junction solar cells, the ones that achieve efficiencies on the order of 28%. Instead, we may be forced to use commonly available commercial-grade cells, the kind that struggle to make 10% on a sunny day. All in the interest of world peace, I suppose.

If you're a non-US satellite builder and want to buy ITAR-restricted components from the US, there are hoops through which you can jump and forms you can file with the Department of Commerce. This assumes you are a government agency, or giant aerospace corporation, and have your team of lawyers and administrators on staff to wade through months of red tape and reams of paperwork. Most of us in the amateur radio community would be daunted by the requirements and just give up.

Fortunately for our non-US partners, the international marketplace is beginning to spawn offshore, ITAR-exempt suppliers of spaceflight hardware and software. At Delft University in the Netherlands, several members of the team that built the Delfi C^3 satellite have spun off a commercial venture, ISIS (Innovative Solutions in Space) to produce spaceframes, communications boards and groundstations for the amateur satellite community. Wouter Jan Ubbels, PE4WJ, (a call already well-known in AMSAT circles) is designing there a nice alternative to US product and offering it to the world's amateur satellite builders. In Scotland, Craig Clark is doing much the same for spacecraft electrical power systems, batteries and solar cells, through his company, Clyde Space. At the University of Surrey in England, Martin Sweeting, G3YJO, and his colleagues have long produced whole satellites, many of which have sported OSCAR designations. At Marburg University in Germany, Karl Meinzer, DJ4CZ, and his students have for years made major contributions to the constellation of amateur satellites, using as few US (ITAR-restricted) components as possible. Other international players will further expand the range of options, cutting in somewhat on the monopoly once enjoyed by US companies. Another unintended consequence of protecting the world from these dangerous weapons called ham satellites!

An interesting irony is that ITAR restrictions may fly in the face of international law. The United States is, after all, signatory to the UN Space Treaty, which, among other things, bans all weapons systems in space. That same US government routinely sanctions launch of our amateur satellites. Now, if under ITAR our birds are to be considered weapons systems, does this not imply an admitted violation of the Space Treaty? Seems to me, the bureaucrats can't have it both ways.

Yes, our satellites are weapons. We use them to fight ignorance. Unfortunately, sometimes ignorance fights back.

Photo next page

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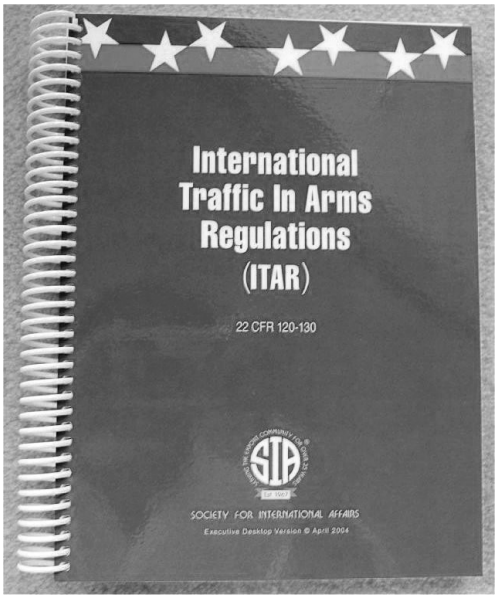

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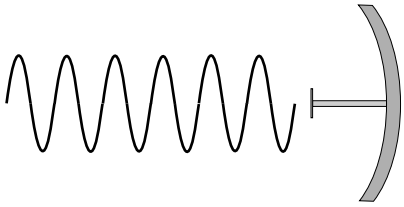
AMSAT-NA in Talks with Intelsat

by Gould Smith, WA4SXM, wa4sxm@amsat.org



It was announced at the 2007 AMSAT-NA Space Symposium and Annual Meeting in Pittsburgh that AMSAT-NA is discussing the possibility of an Intelsat geostationary satellite carrying an amateur satellite payload. The Intelsat satellite would house the amateur payload and provide power and station keeping for the Amateur Radio receivers, transmitters and antennas.

Lee McLamb, KU4OS, AMSAT-NA EVP, recognized the opportunity while attending an Intelsat 'Ride Share' Conference. Intelsat launches their satellites with 1000 W of excess power generating capacity and about 500 kg of available mass, without having to dump fuel. It just so happens that a neighbor of AMSAT-NA President Rick Hambly is a recently retired Intelsat executive and ham. So Rick, his neighbor and Bob McGwier, N4HY, AMSAT-NA VPE, have been working on a proposal and have had a number of productive meetings with Intelsat in developing that proposal. Bob has initially dubbed this project Phase IV Lite. Phase IV satellites were proposed by Jan King, W3GEY,after AO-13 went into orbit.

Bob feels that things have progressed to a point that the engineering team needs to start addressing the issues of what the payload requirements must be to provide a package that will operate over the 15-year lifespan of the Intelsat satellite. One of the benefits of the development work done for Eagle is that most of the communications packages proposed for Eagle can also be used for both the geosynchronous satellite and Eagle.

First of all, I want to assure everyone that there will be an analog transponder as part of the package. It will have an SDX core as planned for Eagle, and will operate better than previous AMSAT analog transponders. In addition to this traditional transponder, there will be the ACP (Advanced Communications Package). This exciting package will provide high-speed digital communications. These can be a combination of digital audio, digital text or even digital video. Most exciting about this digital component is that a complementary ground station will be designed at the same time and made available for a reasonable cost.

A geosynchronous satellite capable of communication via a small, portable ground unit will allow access to amateur satellite users subject to neighborhood covenants and restrictions. But more importantly, a large number of these portable, widely dispersed ground stations can change the way emergency communications takes place. Hams from surrounding areas can quickly enter a disaster area and establish high-speed communications via a satellite visible throughout North America 24/7.

One of the greatest benefits of this project is that Intelsat will be handling the more difficult tasks of launching, achieving orbit, generating power and maintaining position. We only need to concentrate on providing the transponders, control system and antennas. This in itself will be quite a challenging undertaking, but an exciting challenge for the engineering team.

The engineering team will be developing this project using open specifications and open source development enabling the follow-on development of interoperable devices between diverse disaster response teams. This cross platform communications capability should be a prime resource for funding this project.

This opportunity presents hundreds of questions that are being worked on. Questions such as frequency selection, modes, link analysis, equipment, components, superstructure, advanced circuit board development and testing will all be addressed. As the engineering team continues to refine the system design and components these questions will be answered and made available via the standard AMSAT news sources like the AMSAT Journal and ANS. Lend your support and expertise to this exciting endeavor. Phase 4 Lite could well change the face of Amateur Radio.

Symposium News

Proclamations from Allegheny County and The Govenor of The State of Pennsylvania were received by Bill Kristoff, N3BPB. Bill is a very dear friend of the Wireless Association of South Hills (WASH) ARC and he is a member of the North Hills ARC, Breezeshooters, ARRL and AMSAT. He provided these documents last week just in time for Symposium. WASH and the Symposium committee express our appreciation and gratitude to Bill for getting these proclamations for AMSAT.

COUNTY OF ALLEGHENY

OFFICE OF THE CHIEF EXECUTIVE
PITTSBURGH, PENNSYLVANIA

PROCLAMATION

WHEREAS, the Radio Amateur Satellite Corporation (AMSAT) was founded in 1969 and is a non-profit, volunteer organization that designs, builds and operates experimental satellites and promotes space education; and

WHEREAS, AMSAT partners with government, industry, educational institutions and fellow amateur radio societies to encourage technical and scientific innovation, and to promote the training of skilled satellite and ground system designers and operators; and

WHEREAS, the 2007 AMSAT Space Symposium will be held at the Pittsburgh Airport Marriott from October 26 through 28 with keynote speaker Sy Liebergot, Electrical, Environmental, Consumables Flight Controller on Apollo missions 8 through 15; and

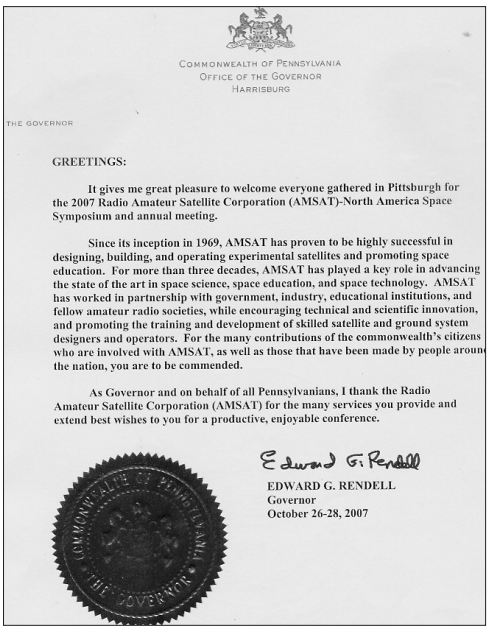
WHEREAS, during the 2007 Symposium, AMSAT will focus on attracting area middle and high school students interested in science and space exploration.

NOW, THEREFORE, BE IT RESOLVED that I, Allegheny County Chief Executive Dan Onorato, by virtue of the authority vested in me, do hereby proclaim Friday, October 26, through Sunday, October 28, 2007, "AMSAT Space Symposium Weekend" in Allegheny County.

FURTHERMORE, I do hereby commend AMSAT on its continued dedication to encouraging scientific advancements and space education.

IN WITNESS WHEREOF, I have hereunto set my hand and caused the Seal of the County of Allegheny to be affixed this 15th day of October 2007.

DAN ONORATO
Allegheny County Chief Executive



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THE GOVERNOR

GREETINGS:

It gives me great pleasure to welcome everyone gathered in Pittsburgh for the 2007 Radio Amateur Satellite Corporation (AMSAT)-North America Space Symposium and annual meeting.

Since its inception in 1969, AMSAT has proven to be highly successful in designing, building, and operating experimental satellites and promoting space education. For more than three decades, AMSAT has played a key role in advancing the state of the art in space science, space education, and space technology. AMSAT has worked in partnership with government, industry, educational institutions, and fellow amateur radio societies, while encouraging technical and scientific innovation, and promoting the training and development of skilled satellite and ground system designers and operators. For the many contributions of the commonwealth's citizens who are involved with AMSAT, as well as those that have been made by people around the nation, you are to be commended.

As Governor and on behalf of all Pennsylvanians, I thank the Radio Amateur Satellite Corporation (AMSAT) for the many services you provide and extend best wishes to you for a productive, enjoyable conference.

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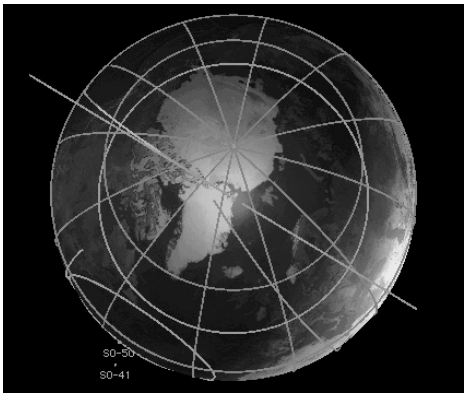

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Repairing Ground Station Transmitting Equipment for 70 Centimeters

by Peter Carr, WW3O, wb3bqo@localnet.com

I returned from Afghanistan and a six month tour for the Navy in July to find that my ground station was broken. Being cheap, err .... frugal, I use a ten meter rig with an upconverter and power amplifier to operate on 70 cm. The rig is a President HR2600 by Uniden that normally puts out 25 watts. It's all-mode and has excellent

Photo 1: Radio Shack box with 0-500 ma meter attached to the front.

modulation, but the output is way too high. Luckily, the designer must have foreseen that because they added a power control. It's on the circuit board under the top lid.

The upconverter is a Hamtronics model XV4 that takes in 1 watt FM/CW and outputs 1 watt at 435 MHz. It's linear so any mode will work with it. It was built from a kit and I still had the paperwork. The power amplifier is a Mirage D-26 that makes 60 watts from 2 watts of input. Since I am only using 1 watt of input the final power is somewhere around 38 watts on 70 cm.

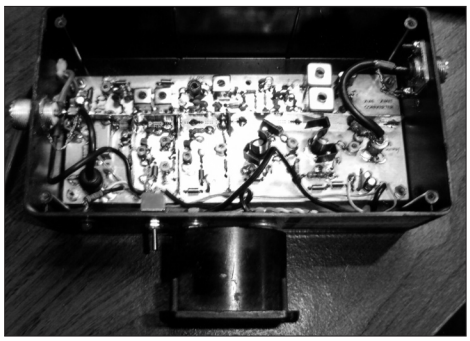

Photo 2: The VX4 upconverter mounted inside the box. Input connector is at left.

The trouble was indicated by the absence of light from the "RF" LED on the front of the Mirage. That tells me that there was either no RF getting to the amplifier or it was so low that it wouldn't trip the amplifier T/R relay circuit. I powered up a Yaesu VR-1 HT and tuned to the upconverter output frequency. The carrier was present on the Yaesu but the level was low. I checked the HR2600 modulation on FM and it sounded just fine on the Yaesu.

The upconverter is housed in a Radio Shack plastic box with metal lid. I removed the four screws and the lid and found that the center conductor of the input RF cable was broken at the SO-239 connector. Because I had used a connector that didn't have a 4-hole flange, the whole thing had turned when the RF cable from the HR2600 was screwed on. I got out the tools and was about to resolder the connection when I noticed a burned resistor on the circuit board.

After digging out the XV4 paperwork I found that the resistor was R17. It, along with R16 form the input circuit for the double balanced mixer and are hardwired to the RF connector I was about to repair. R17 was 680 ohms at 1 watt while R16 was 47 ohms. R16 was not damaged but the series resistor R17 was toast. I pulled the board and replaced the resistor.

Once the board was reinstalled in the box and the RF connectors were resoldered it was time to do a bit of testing. I wondered why R17 had blown. That might indicate that the HR2600 was making too much power. I pulled the rig's top cover and then connected a terminating wattmeter to the output. The instructions for the XV4 show that a FM/CW limit of 1 watt should be used for the input. I set the HR2600 in FM mode and adjusted the power pot on the near the left rear corner of the circuit board. Then I connected the rig to the XV4 input connector and moved the wattmeter to the upconverter output. The instructions for installing R17 in the XV4 circuit board are that it is to be raised off the board for airflow. They must intend for the 1 watt resistor to get warm. To test the theory I put my finger on R-17 and keyed the rig. The upconverter front panel milliamp meter read just under 200 ma at idle. With everything adjusted and the rig in FM mode the meter

Photo 3: The President HR2600 with the XV4 powered up at idle.

indicated 480 ma. I held my finger on R17 for well over a minute and there was only a slight rise in its temperature. This is probably the most non-technical method ever devised for checking operating parameters but it works. If I get longwinded on AO-51 and toast R17 again it will be my own fault.

I reattached the upconverter to the top of the HR2600 and reconnected all the cables. Then I ran a cable over to the Mirage amplifier and hooked up the antenna. I turned on the Yaesu HT and keyed up the entire transmitting equipment chain for a voice test. The modulation was good with no defects.

Several things were learned from this experience. First, I keep a big box into which all the schematics, instructions and parts list are put. They are just dumped in there so it takes a bit of time to sort through the pile. Still, I at least know where to go to look. Second, I usually pay for taking shortcuts. The upconverter output RF connector had a flange so it couldn't turn when a cable was screwed down. I used a non-flange type at

Photo 4: At left is the Mirage amplifier with the Yaesu FT-290 rig on top. The President HR2600 and XV4 are on the right.

the input that wasn't tight enough to prevent turning. Third, The issue with R17 may show that the power pot on the HR2600 circuit board is dirty or was not set to the right level initially. I plan to hook up the wattmeter to the rig every so often to see if the output changes.

After being off the air for so long I'm actually looking forward to fighting with Doppler shift, signal fades and the host of other conditions unique to satellite operation. It's also great to sit back while listening to the downlink and scan the meters and LEDs of the station knowing what is going on behind them.

A Modular Approach to Ground Station Control Software Design

by Scott Wilson, NW2S, s.wilson@yahoo.com

Introduction

Much of the existing satellite oriented software and hardware infrastructure is steadily aging and is becoming harder to maintain. Operating systems are dropping support for many of the tried and true interfaces and libraries that are the foundation of the bulk of today's satellite control software. At the same time, the amateur satellite community continues to innovate by squeezing more out of the current satellites and designing more features into future satellites.

The next generation of ground station control software needs to be able to meet the challenges of this changing landscape of satellite operations: new radios, new satellites and fundamental changes in operating systems and computer hardware. Ultimately, the software should also foster and support as much experimentation as the rest of the amateur pursuit.

Designing software to meet these goals effectively requires re-architecting the classic screen or GUI-based satellite prediction and control application - not an undaunting task by any means. Fortunately, there are a few resources at hand.

First, we must learn (and perhaps borrow) as much as possible from existing open source projects. There is a lot of work that shouldn't go wasted, both in the form of code and documentation. We will, for example, be able to encapsulate a number of algorithms from sources such as Michael F. Henry's "OrbitTools" and "Predict" from John A. Magliacane, KD2BD. Additionally, Paul Williamson, KB5MU's "One True Rule for Doppler Tuning" and Anthony Monteiro, AA2TX's paper titled "An Object Oriented Approach to Automatic Radio Tuning" both outline the established best practices for tuning and object modeling.

The second place we should look to for help, and the one on which this article focuses, is the practice of pattern-based development. Design patterns are repeatable solutions to commonly occurring design issues. Using patterns will provide tested, proven development paradigms, help to prevent subtle issues, and improve code readability for those familiar with the patterns. In short, patterns will help us to design a piece of software that is easy to maintain and extend.

Lastly, we will need a solid foundation on which to base the application. It should provide at least support for advanced design concepts, native platform independence and hopefully has wide support base with a number of useful tools and libraries.

Application Model

The requirements outlined in the introduction could describe what, in modern software design, is called an agile application. An agile application is defined as a loosely coupled set of functional units tied together by an orchestration layer which is easily modified to address changing needs and is scalable by design.

For now, let's call the orchestration layer the controller. The controller will ultimately be in charge of two tasks. The first is bootstrapping the application by loading itself and each of the functional units into memory. Unfortunately, it does not know what type of functional units it will be loading. In fact, no one can predict what functional units may be required in the future no matter how well the application was designed. To solve this problem, we will use the factory pattern to load and initialize abstract classes whose actual implementation is independent of its interface to the orchestration layer.

The controller's second responsibility is managing communications between each of the functional units. Let's call these units modules. Each module is capable of either generating messages or receiving them. A module notifies the controller of its interest in a particular type of message by subscribing to it. Any number of modules may subscribe to one type of message so that they are all notified of the same message. This pattern is called the message bus and effectively isolates the operation of each module and defines their interaction through formal messages.

Figure 1 illustrates a number of possible modules and the controller as a message bus.

Modules should have a well-defined and concise scope of responsibility. Generating satellite data, tuning a radio, or displaying information in a GUI are examples of some tasks each module might be responsible for. Each module should operate completely independently of the other modules, generating messages only within its scope and subscribing only to messages, which affect its operation. Isolating the modules in this manner will greatly simplify debugging and extending functionality.

We can now identify some of the possible message types and outline a possible message-handling scenario.

A typical message handling scenario is as follows:

1. The DataSource module periodically computes satellite states for all of the satellites it currently knows about issues a SatelliteChange event for each update.
2. The GUI receives each SatelliteChange event and regularly updates the display based on the messages it receives.

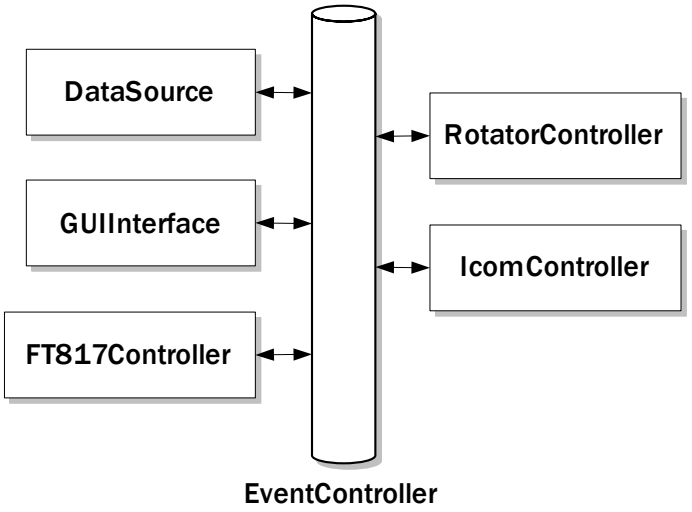

Figure 1 – Message Bus Pattern.

Message Type	Description
Start Track	Indicates that tracking should be initiated for a given satellite. The StartTrack event includes the name of the satellite and the name of the mode.
Satellite Change	Indicates that a satellite's state has changed. Provides current azimuth, elevation, and Doppler values
Aos	Indicates that a satellite has risen above the horizon
Los	Indicates that a satellite has fallen below the horizon

Table 1 – Sample Message Types.

3. The user watches the display, and uses the interface to manually select a satellite to begin tracking. The GUI module issues a StartTrack event.
4. The three modules which are subscribed to the StartTrack event (FT817Controller, IcomController, and RotatorController) each note the satellite to begin tracking and at this point begin listening to the appropriate SatelliteChange events.
5. The RotatorController simply watches the updated satellite data for azimuth and elevation data as the satellite passes overhead and matches the values.
6. The radio controller modules note the current Doppler correction values and adjust the uplink and downlink frequencies accordingly.
7. As the satellite passes below the horizon, a LOS event is triggered and the three controller modules return to their initial state until another StartTrack event starts the process over again.

Data Model

Just as the application design is based around an agile architecture, the data store should be robust and flexible. We need to anticipate the fact that the future needs of the application may differ from those of today and ensure that today's decisions will have minimal negative impact on the evolution of the application. The data model is similar to what referred to as the object model, but extends to represent how the data is persisted and presented in a human-readable form.

The hierarchical nature of object-oriented programming lends itself towards a hierarchical data model. It is possible to visually represent the underlying object model and is similarly extensible. Many of today's runtime frameworks also support the direct creation of in-memory objects from persisted data in hierarchical formats such as XML.

Storing satellite configuration data in a hierarchical format as described in Figure 2 easily maps to a data structure which allows the application to not only know the satellite's current state, but also which modes are available as well as the mode's frequencies and emission type.

The framework should provide not only a common data repository, but a common mechanism for multiple modules to access the same data concurrently. This is achieved by using a thread-safe implementation of the singleton pattern. The singleton pattern ensures that only one instance of the data is available, and the thread-safe implementation ensures that multiple modules may access the data concurrently without causing unwanted side effects.

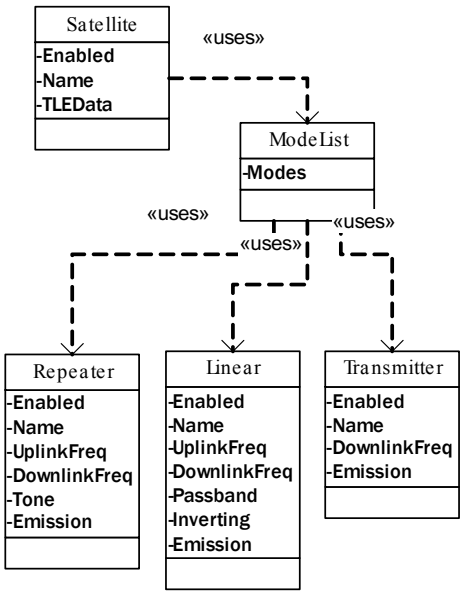

Figure 2 – Satellite Data UML Diagram.

Summary

This brief article describes the architecture of a basic system meant to stand as the framework for a flexible ground station software package. Unfortunately foundational work like this does not have the mass appeal of applications with flashy user interfaces and other bells and whistles, but by building on top of a solid groundwork, the end product will be capable of more features, each with a faster turnaround time than if the application were more monolithic.

It should be possible to see how a modular approach simplifies experimentation by lowering the initial learning curve of learning the intricacies of orbital mechanics or the finer details of CAT programming. The developer, instead, is left to concentrate only on the realm of the individual module and its public interface. Some other ideas for simple modules, which could operate only on the messages named in Table 1 include:

- A data/audio recorder, which automatically records from AOS to LOS using standard data ports.

- Support for a USB jog/shuttle wheel, which allows tuning around the passband of a linear transponder.

- An auto-tracker, which automatically issues StartTrack messages for a number of satellites as they pass overhead and alerts the operator to upcoming passes.

- A GPS module, which automatically updates the base location for mobile operation.

The true strengths would come from implementing useful modules that meet use cases from real operators. I hope that some readers may be curious enough to download the prototype and be inspired to help develop, test, or write use cases. Much more information and downloads can be found at http://code.google.com/p/satcontroller/

The 2007 AMSAT-NA Space Symposium in Pittsburgh
The Weekend That Changed Amateur Radio

by JoAnne Maenpaa, K9JKM, k9jkm@amsat.org

Over the weekend of October 26 through October 28, 2007, amateur satellite operators enjoyed a weekend in the mountains of western Pennsylvania with the autumn leaves at their peak color. The Wireless Association of South Hills, Skyview Amateur Radio Club, Breezeshooters Amateur Radio Club, and Washington Amateur Communications clubs in the Pittsburgh area teamed up to host the 2007 AMSAT Space Symposium at the Pittsburgh Airport Marriott Hotel.

The jam-packed weekend featured the AMSAT Board of Director's meeting, the Space Symposium, the Annual Banquet, AMSAT Annual General Meeting, Field Operations Breakfast, IARU Satellite Meeting, and a student antenna workshop.

As you read this article you too will begin to realize that this weekend was one that marked a change for Amateur Radio. AMSAT announced new satellite opportunities, ways and means to expand our funding by acquiring grants for the unique public service and educational outreach we can provide.

Here are the highlights of this year's Symposium then … several authors have promised to write the full details of their area of expertise in their own articles.

Phase IV Lite

At the Symposium Rick Hambly, W2GPS, AMSAT President along with Bob McGwier, N4HY, AMSAT Vice-President of Engineering were able to make public the results of their recent work which will change the face of Amateur Radio going forward. AMSAT has been in consultation with Intelsat regarding an application of an Intelsat platform carrying our Amateur Radio satellites into geosynchronous orbit.

Bob described changes in Department of Defense policies, which will require DoD subsidized launches to allow secondary payloads to fill in excess launch capacity of the primary mission. During his talk, "When's the Launch", Lee McLamb, KU4OS, explained factors such as the increased size and efficiency of launch vehicles now result in excess lift capacity. Gone are the days where adding a pound to the payload meant removing a pound of fuel from the booster. Lee described how current missions on the schedule have 1000 to 1500 pounds of excess capability. These are slots AMSAT can fit into.

Even in this new environment these launch opportunities will not simply be given away. Intelsat and other commercial satellite companies need to make a business case to their corporations regarding their primary mission. While they can no longer refuse secondary payloads compatible with their primary mission, AMSAT will need to cover certain costs of the launch. AMSAT needs to now make its own business case to secure this funding through grants. We can offer a leap forward in emergency communication coverage plus unheard of educational opportunity for students to secure these grants. We have to justify our use of these resources so, in exchange for our advanced services, radio amateurs will also get what we want – analog transponders, digital channels, software defined radio, in other words our shopping list of satellite goodies.

Engineering studies, funding studies, among other negotiations have continued after this announcement. However Bob, N4HY made the following observation of the Phase IV Lite project, "There is enough in place at this time that AMSAT needs to begin planning engineering work and possible construction of a geosynchronous payload so we are ready if Intelsat says they have a ride for us."

Need to Plan a Phase IV Payload

The Phase IV Lite Geosynchronous Payload is planned to consist of transponders already under development for the Phase 3 satellites. Accelerated development on the digital Advanced Communications Package (ACP) is anticipated. In addition to the ACP communication payload flown to space, AMSAT plans to develop an earth station attainable by the average ham so that users can immediately take advantage of the audio, digital messaging, and video services. Details of the payload and earth station are planned to be covered in future articles in *The AMSAT Journal*.

Phase IV Introduces a New Era for Emergency Communications

The Advanced Communication Package would be a self-contained earth station, which could be sent with Amateur Radio communication teams or delivered to disaster areas for 24/7/365 emergency communications. These teams would be able to point a small dish at a predictable spot in the sky and immediately begin delivering disaster communication support without depending on HF propagation.

Phase IV Educational Opportunities Are Mind Boggling

A Phase IV payload could also be used to provide TDRSS-like relay of ARISS communications. The 10-minute school contact could now be expanded to hours long contact with the International Space Station. This opens possibilities for student involvement with experiments aboard the space station.

Let's Get Started!

The Intelsat geosynchronous platform would be able to provide the AMSAT Phase IV Lite payload with approximately 400 watts of DC power for 15 years. The primary payload would also perform the GTO boost phase as well as perform station keeping and antenna pointing once it has arrived on station. Bob, N4HY summarized, "The Intelsat team would be doing all the things nearly impossible for amateurs and that enables AMSAT to do what we do best ... build a communication system that changes Amateur Radio for the better!"

Phase 3E Update

Hartmut Päsler, DL1YDD, Vice-President and Board Member of AMSAT-DL, discussed the current status of the P3E and P5A missions. Hartmut explained that P3E is nearing completion for assembly and testing with international cooperation from AMSAT-NA and AMSAT-UK. The ZEL laboratory may be closed by the end of 2007 or early 2008 as P3E is completed and will be ready for launch.

AMSAT-DL is currently investigating launch opportunities with Arianne and Soyuz-2 from the ESA Spaceport in French Guiana. Additional launch opportunities may arise with Intelsat as was disclosed this weekend.

Hartmut also gave an update of AMSAT-DL's refurbishing and operation of the ESA Bochum 66' Dish. The main mission of this antenna will be for the P5A mission to Mars. During testing this dish has been used to receive signals from planetary probes and

Voyager at the edge of the solar system. We heard a recording of a single-side-band EME demonstration with the dish.

AMSAT Eagle Update

The current baseline plans for Eagle's linear transponders are being expanded into dual-use for Phase III and Phase IV application:

- UHF uplink / VHF downlink transponder with 100+ kHz bandwidth using Software Defined Transponder (SDX) technology.
- There will also be a linear transponder uplink (also SDX) at L-band 1269 MHz uplink / S1-band 2400 MHz downlink.
- The L/U and V/S1 links can also be cross-strapped for cross-band flexibility.

The details of the Advanced Communication Package are still being worked on. High-level requirements are being proposed that include these capabilities:

- S2 band-3400-3410 MHz downlink & C band-5650-5670 MHz uplink (10 MHz segment TBD).
- Phased array with up to 22.4 dBi gain is under study
- Uplink and downlink would be accessible to hams not already on satellites or facing antenna restrictions.
- 60 cm dish would work
- Simultaneous development of earth-station package accessible to the average ham.
- Earth stations available for EMCOMM teams and educational outreach.
- Probable capacity of 500 voice grade channels and video – scalable data rates depending on the class of the communication application.
- Low rate text messaging to hand held devices is proposed.
- Studying range of 200 watt transmitter on satellite, asynchronous uplink-downlink with FDM up / TDM down, with 50 dB Eb/No.
- Prototypes planned for 2008.

The first prototype of KD6OTH's UHF uplink receiver design that had been built, tested and debugged by WA6HTP and the Project Oscar team, was on display and was on the air as a 70 cm to 2m linear transponder.

Robert Davis, KF4KSS showed module prototypes for the Eagle spaceframe. These have been designed by Dick Jansson, KD1K, and Fred Parker, KF0AK. Dick has also designed a prototype of the launch vehicle interface.

Dick Jansson, KD1K, gave a presentation describing the thermal analysis and design of the Eagle spaceframe and modules. Module sizes have been standardized for the payload. These are mounted on fiberglass rails to the spaceframe. Dick described his thermal modeling and analysis of conducted and radiated thermal effects of the modules.

Educational Outreach

Educational outreach, at all levels from elementary through university, continues to be one of AMSAT's primary missions. The Symposium gave many educators the opportunity to share their techniques and results of their present educational programs.

Two new opportunities for educational outreach were revealed during the course of the Symposium presentations. As already outlined in the Phase IV overview AMSAT will be able to provide TDRSS-like relay of ARISS communications. This will allow the 10-minute contact with a school to expand into multi-hour sessions.

Rick, W2GPS, shared the second educational opportunity arising out of AMSAT's cooperative agreement with the University of Maryland – Eastern Shore (UMES). This compact already provides the laboratory facilities for AMSAT's new satellite integration lab in Maryland. The educational outreach is planned to begin during the summer of 2008 when AMSAT and the University initiate the AMSAT Institute. The initial focus of the Institute will be to train a team of educators in space education and satellites. These educators would then branch out and train more teachers to bring AMSAT into their classroom. This is an exciting "train the trainers" program which is expected have a large impact on AMSAT's justification to secure grant funding for our future satellite projects.

Several radio amateurs shared their educational techniques and results from around the world:

- Patricia Palazzolo, KB3NMS, the Pennsylvania Teacher in Space, discussed the ARISS projects she has used in the classroom She also shared the stories of a dozen students, whose lives were touched by ARISS, that went in scientific and engineering careers; including several who earned a PhD.
- David Jordan, AA4KN, shared the ARISS contact with The Arnold Palmer Hospital for Children. This remarkable contact gave 20 seriously ill children a chance to reach outside of their hospital room and forget about being sick but instead dream of everything in their future.
- Hans van De Groendendaal, ZK6AKV, spoke on the need to make Amateur Radio "cool" from the children's point of view. Hans also shared details of the new South African LEO satellite developed in cooperation with University programs.
- Stefan Wagener, VE4NSA, described the WinCube satellite being built by the high school and university students in Winnipeg, Manitoba, Canada. The WinCube program gives students a chance to try their hand at all levels – satellites, high altitude balloons, rocket launches, and Amateur Radio classes.
- Bob Twiggs, KE6QMD, talked about student involvement at all levels – satellites, high altitude balloons, rocket launches, and robotics.
- Ivan Galysh discussed and demonstrated the educational aspects of the CanSat project for schools.
- Peter Arslanian and Michael Dunn showed their work with UMES/ HISS Hawk HASP High Altitude Balloon Payload. This is a program in cooperation with AMSAT's agreement with the University of Maryland.
- Guilio Pezzi, IZ4FVW/ AB2VY, described the ALMAsat microsatellite and the development of a satellite laboratory and ground control station at the University of Bolgna.
- Joe Lynch, N6CL, Editor of CQ VHF Magazine gave a talk on how radio amateurs need to get better at "Telling Our Stories" so more of the world becomes aware of the remarkable work we are doing.

A hands-on educational project at the Symposium was led by Richard Crow, N2SPI. Richard led two related student workshops. The first was a "Satellite Antenna Building Workshop", from 5:30 to 7:30 pm Friday evening, October 26, 2007 where students built their own satellite downlink antenna based on Richard's article from the July/August 2006 AMSAT Journal titled, "Build This Cheap and Easy Satellite Downlink Antenna". The next morning, 9 to 10 am Saturday, the students were challenged to actually receive a signal from

a satellite using their new antennas. They were successful in receiving SO-50 with their antennas. Richard will report all of the details in his article about the workshop.

AMSAT thanks Bob Bastone, WC3O, Larry Keller, AB3ER, and Rich Newbould, K3RWN, for their help with the students and the antenna workshop. They assisted Richard by providing the handhelds used by the students and with the Doppler shift which ensured the success of the receiving challenge.

AMSAT Maryland Lab

Robert Davis, KF4KSS, AMSAT Lab Manager and Assistant Vice-President of Engineering showed photographs and discussed the progress of building out the new AMSAT Satellite Integration Laboratory in Pokomoke, Maryland. This laboratory is a collaborative effort between AMSAT and the Hawk Institute for Space Sciences (HISS), a division of the Maryland Hawk Corporation which is a 501(c)(3) non-profit educational organization affiliated with the University of Maryland - Eastern Shore. HISS is located in Pocomoke, Maryland, on the eastern shore of the Chesapeake Bay. This facility is about two and a half hours southeast of Washington, D.C. and is also near the NASA Wallops Facility.

The clean room walls have been cleaned and are currently being assembled. The contractor for the fire sprinkler system is expected to complete work in early November. The office walls have been completed and the laboratory, electrostatic workstations, soldering equipment, and machine shop are nearing final stages of construction.

The 5000 square foot facility will also house a satellite earth station expected to be installed in February 2008. The laboratory will begin to be used with a university CubeSat project in accordance with AMSAT's agreement. The Eagle satellite will be built and integrated at this facility also.

AMSAT's lab was also utilized for a university student project called the HAWK High Altitude Student Platform (HASP). This was an interdisciplinary program with fourteen students that built and launched a balloon project to 120,000 ft. The program will continue at the AMSAT lab in 2008 and will be able to handle higher capacity payloads.

SuitSat-2

Lou McFadin, W5DID, described the ongoing design and construction of the communication and experimental payload for SuitSat-2. The new SuitSat will provide a flight test of Eagle hardware and software by using the IHU computer and the software-defined transponder (SDX). Also, the SuitSat-2 electronics package will be suitable for integration into future CubeSat projects.

The SuitSat-2 project will feature:

- Expanded educational outreach
- Linear software defined transponder
- CW ID
- Voice messages
- FM Crossband Repeater
- SSTV images of the earth from 4 cameras
- Temperature sensors
- Room to accommodate 4 experimental packages
- CD-ROM containing student art and messages

The transponder bandplan and detailed description of SuitSat-2 are summarized in Lou's paper in the *Proceedings*. Lou reported an integrated system test is planned for February 2008 with delivery of the flight hardware in June 2008.

Human Space Flight - ARISS

Frank Bauer, KA3HDO, ARISS International Chairman discussed 7 years of continuous operation of the ARISS program. As of this time the ARISS program has made over 330 school contacts by 16 consecutive amateur licensed crews. The program touches over 15,000 students per year. AMSAT is a key partner in the ARISS program.

ARISS plans were discussed:

- Packet operations will continue on 145.825 MHz until the radio inside the ISS is reprogrammed.
- Educational Outreach will continue to expand with pre-planned lessons available to teachers.
- SuitSat-2 integration with ARISS will continue in 2008.
- SuitSat-2 prototype core radio is under consideration for ARISS Phase 3.
- Daniel Lamoureux, VE2KA, and Stefan Wagener, VE4NSA, are new ARISS delegates.
- Thanks go to James Pulfer, VE3PU, and Robin Haighton, VE3FRH, for their service to ARISS. They are retiring after many years of service.

The Banquet

Our keynote speaker this year was Mr. Sy Liebergot, a former EECOM controller responsible for the electrical and environmental systems onboard the Apollo Command Module. He was part of the team that guided Apollo 13 back to Earth following the explosion that crippled the spacecraft. Sy had recordings of the communications and photos to accompany his personal description of the events.

AMSAT-NA Annual Meeting

Rick Hambly, W2GPS, led the AMSAT Annual Meeting. This was also carried live via the AMSAT conference on Echolink. Much of the discussion during the meeting centered on all the key points already presented in this article. Rick, along with the officers and Board Members were on hand to personally answer questions.

In summary, AMSAT's main goals and mission for the coming year include:

- Phase 3 High Earth Orbit Satellites
- Phase 4 Lite Geosynchronous Satellite
- Educational Outreach
- Completion of the AMSAT Satellite Integration Lab in Maryland
- Partnership and support of other organizations who wish to build and launch LEO satellites
- Funding and grants to support the AMSAT mission.

AMSAT members were recognized for their contributions to the organization. A list of the 2007 AMSAT President's Awards will be published in the next *Journal*.

IARU Meeting

AMSAT-NA hosted this year's IARU International Amateur Radio Satellite Forum which is held alternately in conjunction with the AMSAT-NA Space Symposium and the AMSAT-UK Colloquium. Additional news from this meeting will be published in the Journal as it becomes available.

Area Coordinator's Activities

Gould Smith, WA4SXM, gave a presentation "Introduction to Amateur Satellites" which gave beginners the basic information to get started. Gould discussed being able to get on many of the amateur satellites using the gear you already have. He pointed out that huge antennas are not necessary to get started and included several examples of easily attained antenna configurations.

Sunday morning featured the Area Coordinator's Breakfast, allowing all to touch

Symposium continued on page 12 ...

The 13 cm Satellite Band: Downconverter Frequency References, Temperature Stability and Noise

by James A. DeYoung, KG4QWC, kg4qwc@arrl.net

In 2006, to begin to prepare for P3E, I purchased a K5GNA modified AIDC 3731 (13 cm band 2.4 GHz) downconverter and a Gardiner LO2398 reference signal source to compliment the capabilities of my Icom IC-910H transceiver. The K5GNA documentation stated that the Gardiner reference signal should be downconverted to near 141.840 MHz (+/- 100 KHz) by the AIDC 3731 [1]. The K5GNA documentation frequencies seem to have been originally specified by K5OE in an AMSAT Bulletin Board (BB) submission [2]. The Gardiner reference frequency in the documentation was specified to be located at 2.397840 GHz. However, it was noted that in my system the Gardiner reference frequency was downconverted by the AIDC/IC-910H to near 141.998 MHz plus or minus a few kilohertz. This difference and associated uncertainty, as well as the difficulty in finding the AO-51 downlink when in S-band mode, prompted me to find the actual reference frequency and the appropriate LO offset for SATPC32 automatic tuning. In addition, I tested and modeled the Gardiner reference frequency accuracy and stability as well as the AIDC/IC-910H frequency accuracy and stability with temperature. This paper will also explore the observed satellite sub-band noise/QRM levels in light of the existence of the large number of 802.11 devices where I live in the region of a large city.

The Gardiner Signal/Frequency Reference

The system diagram with the Gardiner LO2398 frequency/signal source reference [3] and the normal satellite communications receive components made up of the K5GNA AIDC 3731 [4] and the Icom IC-910H is shown in Figure 1 [5]. The initial effort was to measure the Gardiner absolute frequency and its temperature behavior to be able to remove it leaving the AIDC 3731 and IC-910H LO offset behavior with temperature for input into SATPC32.

Using my Icom IC-706MKIIG (IC-706) and by coupling the Gardiner metal case to the HF antenna input the actual fundamental crystal frequency was found and measured at 11.9900 MHz. My IC-706 has the CR-282 0.5 ppm high-stability crystal installed and has been tested and frequency display biases have been evaluated several times using the ARRL Frequency Measurement Test (FMT) [6,7]. The measured crystal fundamental frequency is significantly different from the 11.9892 MHz specified in the K5GNA and K5OE references [1,2].

The next effort was focused on independently finding and measuring the Gardiner 13 cm reference frequency. The freshly confirmed 11.9900 MHZ crystal's 200th harmonic output should be found near 2.398 GHz. Using a BK Precision 2650 spectrum analyzer (Span 200 kHz, RBW 3 kHz, VBW 100 Hz, Sweep 0.3 s) I found and measured the 200th harmonic LO at 2.398002 GHZ +/- 2.5 kHz measured at –3 dB at 23^{o} Celsius. This is not near the K5OE/K5GNA implied 2.397840 GHz. This is a difference of about 160 kHz, which makes a huge difference when searching blindly for weak satellite downlink signals with a 0.5, 2.3 kHz or 15 kHz filter! Figure 2 shows the spectrum using the max-hold feature of the spectrum analyzer over about 10 minutes of time, which smoothes out random spectral components in the wings. There is a "pedestal" on which the sharpest peak is located upon. The pedestal is formed because at each 0.3 sec sweep the spectrum is actually made up many moving sidebands surrounding the central peak. Over time the moving sidebands are smoothed into the observed pedestal. The sharp central peak was not moving and allowed a good precise measurement of the Gardiner local oscillator (LO) frequency.

The Gardiner absolute frequency behavior with ambient air temperature measured within a few inches of the Gardiner was investigated next, Figure 3. The measurements were made with the spectrum analyzer, a digital thermometer sampling the air temperature within a few inches of the Gardiner and placing the Gardiner in various temperature environments. The temperatures achieved ranged from 13 degrees to 27 degrees Celsius. Equation 1 shows the Gardiner absolute frequency (Gf) with temperature in Celsius using a linear least-squares model. The coefficient standard error estimates are indicated inside the paranthesis.

$$Gf_{GHz} = -0.000001662\ (\pm 0.000000043) * Celsius - 2.39804119\ (\pm 0.00000082) \quad 1)$$

The number of points used in the fit was 139, the standard error estimate was 1.8 kHz, and the correlation coefficient was 0.958.

The Nominal Receive System: The AIDC 3731 and IC-910H

Once a good model of the Gardiner signal source absolute frequency behavior was obtained, the next thing to do was to determine the offset and stability of the LO of the normal receive system components, the AIDC and IC-910H, Figure 1. The goal being to be able to setup my receive

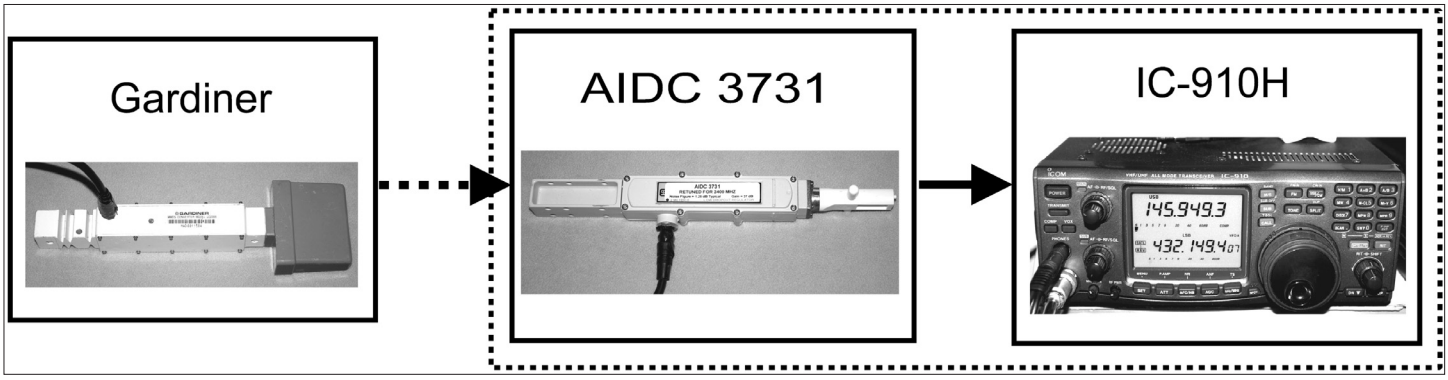

Figure 1: The 13 cm system diagram containing the Gardiner LO2398 reference signal source, the K5GNA modified AIDC3731 13 cm downconverter and the Icom IC-910H transceiver. The nominal 13 cm receive components are located inside the dash outlined box. (KG4QWC photos.)

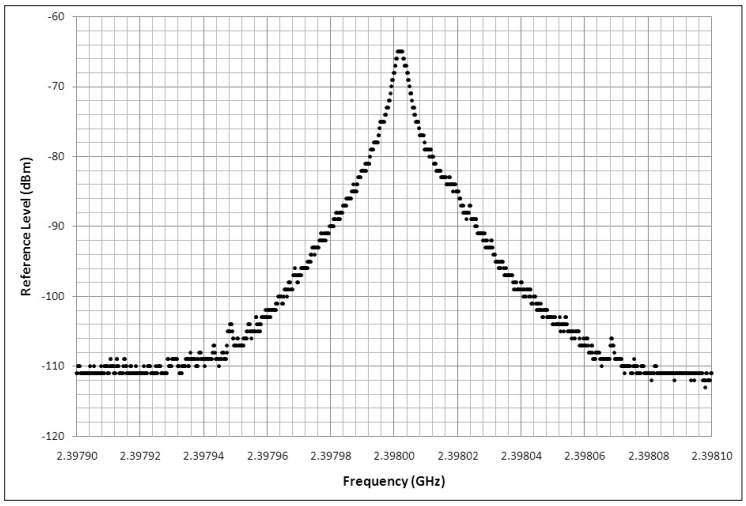

Figure 2: The BK Precision 2650 spectrum analyzer frequency spectra of the Gardiner 11.990 MHz crystal's 200th harmonic. The reference signal, which is the 200th harmonic of the crystal fundamental of 11.9900 MHz, was measured at 2.398002 GHz +/- (2.5 kHz) at the –3 dB point at 23^{O} Celsius.

system and be able to directly tune to the desired absolute frequency and have great confidence that the system would be within a few kilohertz of the desired frequency.

The method of measurement involved sending the audio output of the IC-910H into a laptop sound card. Spectrogram Version 11 and later Version 15 software[8] was used for the precision measurements while the IC-910H was used in 1 Hz tuning resolution. The IC-910H was used with the USB filter selected and the IC-910H was tuned to the nearest kHz that placed the down converted Gardiner reference signal into the USB filter passband. The frequency of the Gardiner signal source was read to 1 Hz by setting the Spectrogram cursor on the signal peak and reading it off and logging it to the spreadsheet. In a spreadsheet the offset was added to the IC-910H tuned display frequency giving the actual frequency to within about 1 Hz, Figure 4. The IC-910H manual specifies a frequency stability of +/-3 ppm over the temperature range at 2 m which has been shown in previous work to be significantly better since the environmental temperature is kept stable to within a few degrees Celsius[9].

Additionally, I measured and logged the air temperature in the near-region, within several inches, of both the Gardiner and AIDC. Several combinations of measurement setups were done by placing the Gardiner/AIDC into situations of warm/warm, warm/cool, cool/warm, and cool/cool. For example, I put my kitchen refrigerator freezer and chill box as well as my house air conditioners to scientific use by placing the Gardiner signal source and/or the AIDC into various temperature environments therefore sampling the receive system temperature dependencies.

The physical idea is that the down converters generate thermal energy that is dumped to the local ambient temperature heat sink of the air surrounding the device. The device's internal operating temperature is then related to its heat dump efficiency to the nearby volume of air. The crystal frequency, filters, etc. in the device being sensitive to internal temperatures defines the final physical relationship defining frequency accuracy and stability. Sufficient time was always allowed during each experiment for the Gardiner and AIDC to stabilize in frequency. There probably is also an atmospheric water content dependency but relative humidity was not measured during these tests, but could be to gain some improvement in the model fits statistics.

The IC-910H was always left in its normal operating position and environment which is stable to a few degrees Celsius at normal room temperature. The linear model for the Gardiner reference frequency with temperature, equation 1, allowed its removal leaving the desired AIDC/IC-910H LO offset and variation with temperature. The best predictor model for the LO offset with respect to temperature was found to be a linear one estimated from the mean temperature formed from both temperatures, one being measured near the Gardiner and the other near the AIDC, Figure 5. Equation 2 shows the first order least squares model relationship of the LO frequency offset with mean temperature in Celsius.

Removing the model of the Gardiner signal source absolute frequency with temperature model, Equation 1, from the full system measurements point-by-point gives the following estimate of the LO offset with mean temperature between the Gardiner and AIDC/IC-910H.

$$LO_{GHz} = 2.2560401\ (\pm 0.0000009) - 0.00000152\ (\pm 0.00000004) * Celsius \quad 2)$$

The number of points used in the fit was 129, the standard error estimate was 2.9 kHz, and the correlation coefficient was 0.966. This LO offset model then is at the 1 sigma level good at one USB filter width.

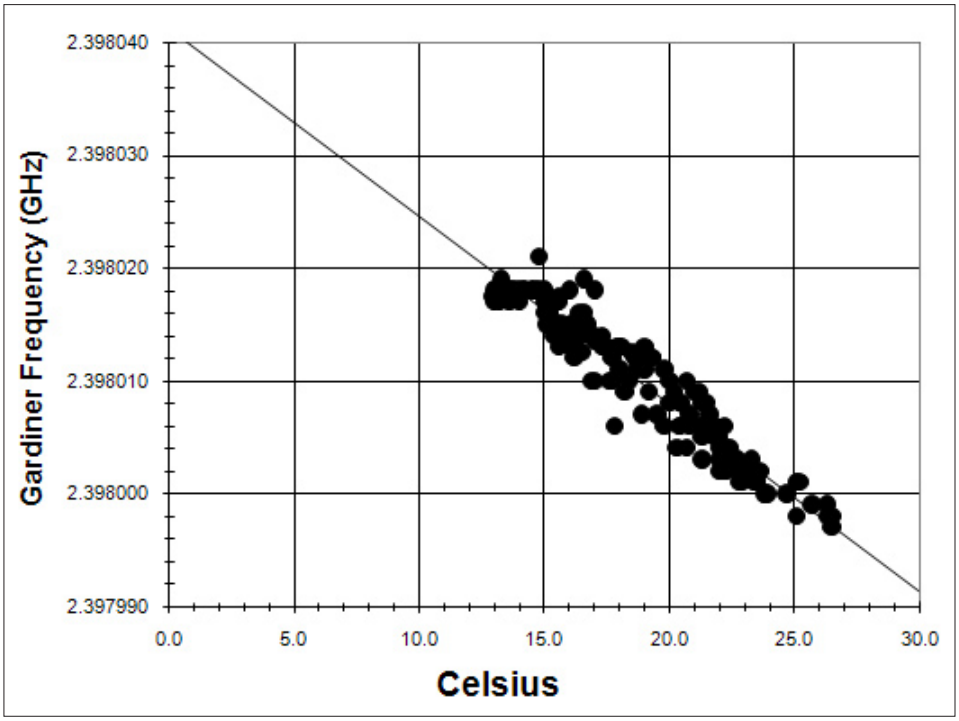

Figure 3: Plot of the Gardiner absolute frequency with temperature measured, range 13 to 27 degrees Celsius using the BK Precision spectrum analyzer. The filled circles are the temperature data from near, within a few inches, of the Gardiner. A linear least-squares model was developed; see Equation 1.

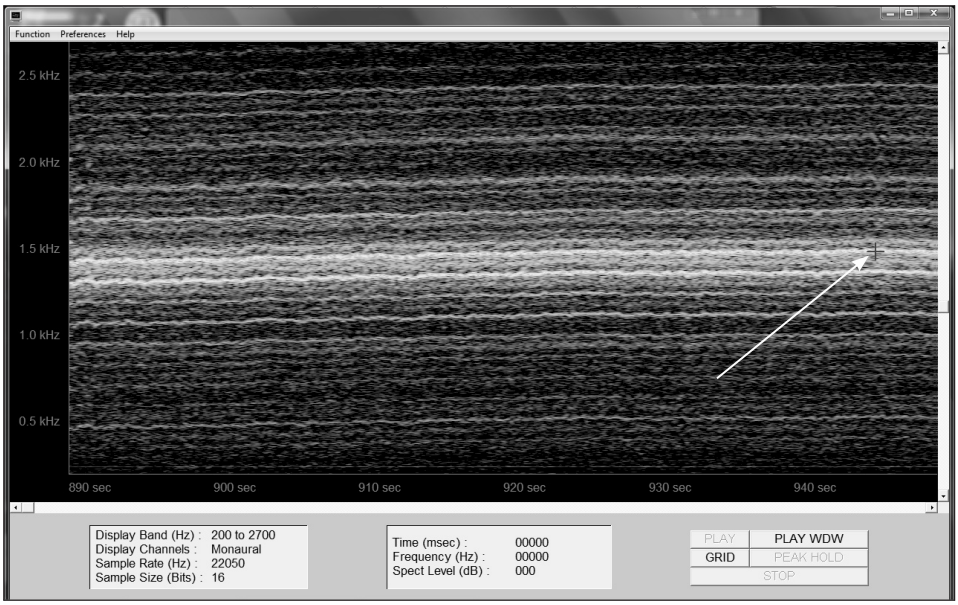

Figure 4: The Spectrogram waterfall (60 sec window) audio based spectra of the AIDC down converted Gardiner signal source as received by the Icom IC-910H. The frequency of the cursor, located near the right edge, is added to the base IC-910H display frequency to give the actual frequency of the Gardiner signal.

13 cm Satellite Band Man-Made Noise

I live inside the beltway of Washington, DC. The immediate metropolitan area population estimated in 2006 July 1 was 4.1 million[10]. This would imply that it should be an active RF environment and it is! Remember the old adage, "one man's noise is another man's signal"! A great deal of the "noise" in the 13 cm satellite band portion of interest is generated by frequency hopping 802.11 devices. I asked myself what filter available in most receivers will reduce "clicker" pseudo-impulse noise sources? The answer is the noise blanker circuit (NB) [11].

Figures 6 and 7 are plots generated using Ham Radio Deluxe (HRD) [12]. HRD provides a good precision sampled based spectrum tool. I call this tool the "impoverished hams' spectrum analyzer" (IHSA). There is a good amount of dead time, but over time it builds a reasonable estimate of average band activity. Figure 6 shows the sampled spectrum over about 12 hours of time without using the IC-910H noise blanker circuit (NB). Since much of the noise is of the "clicker" type from frequency hopping devices I thought I should sample the spectrum with the IC-910H NB circuit on. A significant difference is observed in Figure 7, which was built up over another 12 hour period over the approximate same time of day several days later. There was no significant difference between daytime and nighttime spectra. P3E's linear transponder passband is indicated as well as the general beacon (GBCN) and the engineering beacon (EBCN). The actual Gardiner reference signal source may be found at the left edge. The AO-51 13 cm FM downlink is located near the right edge.

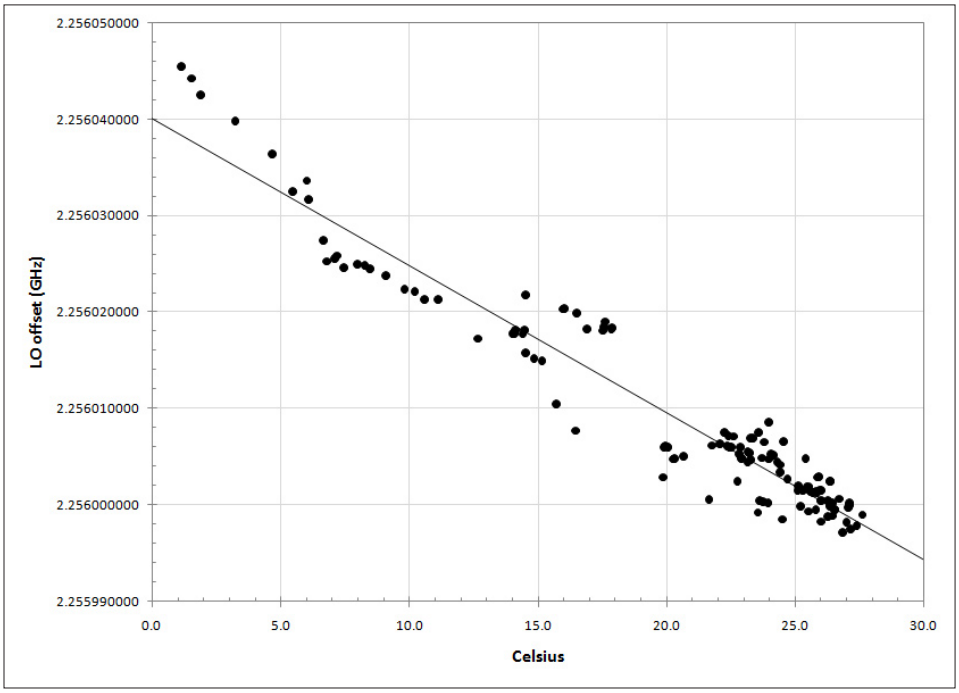

Figure 5: Plot of the AIDC and IC-910H system LO offset against the mean temperature range of approximately 0 to 28 degrees Celsius. A linear least squares model fit to the mean temperature and the LO offset as output was developed, see Equation 2. The upper leftmost point is the mean temperature coming from the Gardiner temperature of -22.2 Celsius and the AIDC at 24.5 Celsius. The lower rightmost average point is formed from the Gardiner temperature of 27.2 C and the AIDC at 27.6 Celsius. This is the "and magic occurred" part!

If you have a noise blanker circuit you should use it. Comparing the IHSA plots, Figures 6 and 7 show the tremendous improvement achieved when using the noise blanker! If a local 2.4 GHz phone is on channel 1 you can get big time QRM, however this has happened only rarely at my location. The more pervasive problem sources are the frequency hopping devices that generate discrete pulses of RF energy. The noise blanker circuit in your radio is the perfect device to knock these down to a reasonable level. As can be seen in the HRD spectra not all the noise is removed, but nearly all. The remaining noise is most likely caused by nearby "clickers" overcoming the noise blanker circuit's ability to remove it.

Future Work and Conclusions

Using the models developed in this study the LO offset accuracy for my 13 cm receive system is now estimated to be at the 6 kHz level at the 95% confidence limit. This should allow nearly direct accurate tuning in all environmental conditions and should greatly enhance operating time efficiency.

It is fairly critical that you turn on your receiver NB when desiring to receive satellite downlink signals in the 13 cm satellite band. There is little doubt that the IC-910H noise blanker does a significant job of reducing in-band pseudo-impulse noise QRM which apparently makes up much of the noise so far observed from my location.

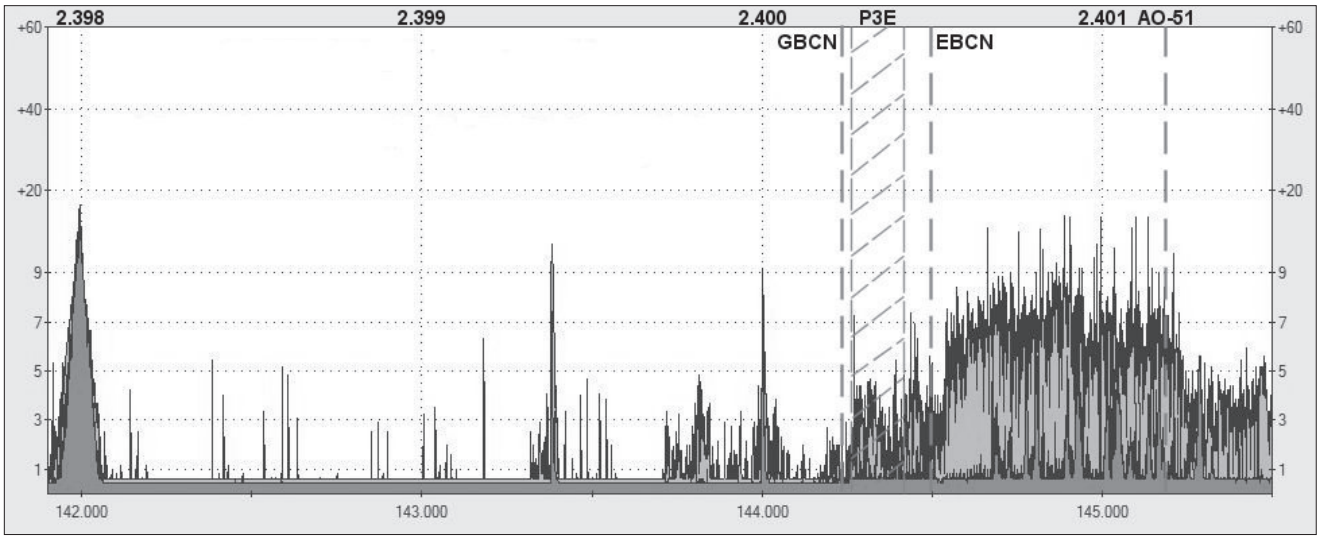

Figure 6: The HRD IHSA spectra showing the 23 cm satellite band noise levels when not using the IC-910H noise blanker.

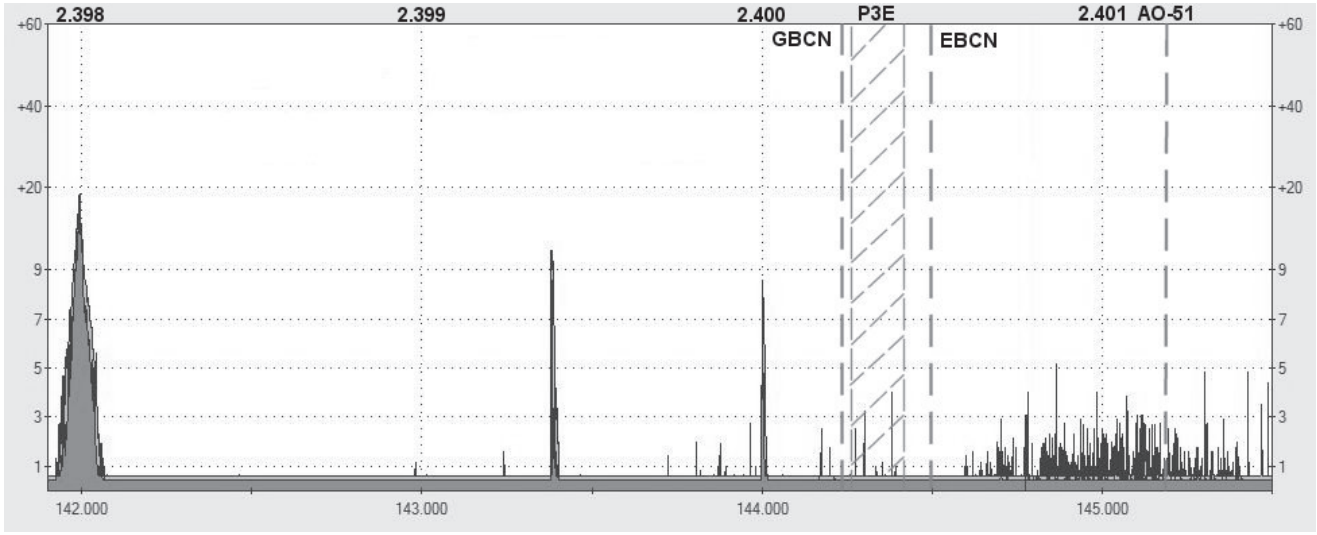

Figure 7: The HRD IHSA spectra showing the 36 to 42 dB noise level reduction when using the IC-910H noise blanker.

The noise level was reduced by about six or seven S units which at 6 dB per S unit means a noise reduction of about 36 to 42 dB.

An opportunity to preliminarily test these results was provided for on 2007 September 12th when AO-51 was in L/S mode. A good pass, 01:04 to 01:23 UTC, was available for my receive system testing based on preliminary portions of this work. AO-51 reached a maximum elevation of 44 degrees from my QTH. Success was achieved using the AIDC with the corner reflector attachment from inside my home in one of my second floor bedrooms. After entering the appropriate LO offset determined from this work into SATPC32 I was able to hear the AO-51 S-band downlink with no additional offset tuning.

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Implementing PocketSat+ on the Palm Zire 71 PDA

by Peter Carr, WW3O, wb3bqo@localnet.com

I recently replaced my Palm M-505 PDA with a Palm Zire 71. It seems that every Web site on the Internet requires a user name and password and gets confusing to remember what combination goes to which site. This list of names and passwords is now easily stored on the Zire. Now all I need to remember is the password for the PDA!

While cruising a listing of programs for the Palm OS I noticed a program called PocketSat+. It is available from Big Fat Tail Productions. I went to their Web page and found that the program tracks satellites and presents map displays of the real time position of a selected satellite. The ground station at home uses InstantTrack and the maps looks very similar to the one on the Web site.

The PocketSat+ program is offered as a shareware version for download. You can register the program for $25 and that speeds up the computations. The author, Jim Berry, suggests that you download and try the program first. He indicates that some PDA versions may not run the program error free and he hates to refund money. I downloaded the program to a desktop. Then I used a utility called Palm Quick Install and then performed a "Hot Sync" operation to load it onto the PDA. The program needs an updated set of Keps, which can be downloaded from AMSAT.org. The file extension of the Keps must be changed to .pdb or the utility will not allow "drag & drop" of the file into its screen. There is also a discussion on the Big Fat Tail Web site about all this information. While the operations are nothing like an old Heathkit assembly manual, it will go well if you read carefully and add patience.

The PDA uses an expansion card of 64 MB size. Not being satisfied to just check the configuration menu of the PDA, I shut it down and pulled the card out. This really disturbed the PocketSat+ program. Obviously, it was the last thing running when I shut down the PDA. Evidently something happens because the map section of the program disappeared. This was discovered when I reinstalled the card and went back into the program. The solution was to reload PocketSat+ program from the desktop.

There was one other difficulty that confused me. When initialized, the program defaults to a date of 14 April 2003. To set the date and time just tap the bottom tab second from the right which is the date. A second screen appears and you can edit the date and time. The format is similar to the date/time sequence in Windows Control Panel.

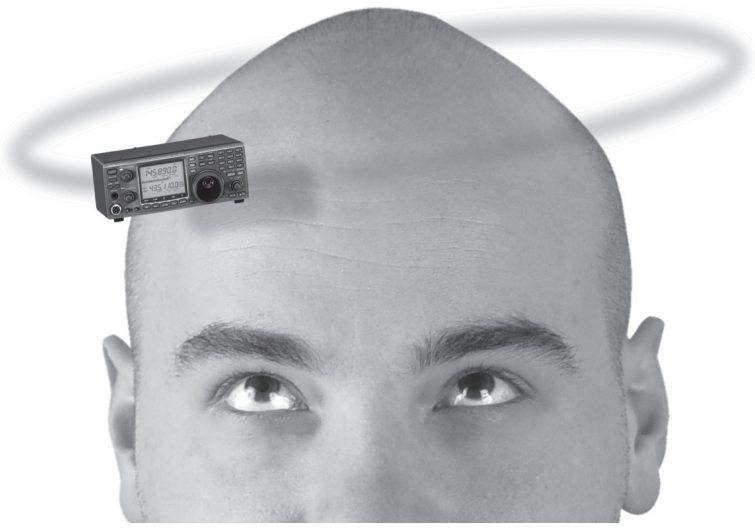
The far left tab allows you to select which satellite you wish to track. A screen listing of the satellites loaded from the Kep file will appear. Tap on the satellite name and then tap "done". Then select the maps tab and the global map appears with the satellite name just below. The satellite will appear at the center of the screen. Use the stylus to drag the image left or right to move the entire presentation. This way you can view your QTH in relation to the satellites present position.

The PDA and tracking program are just the thing for mobile operations. Many people use their PDAs with mapping software so there are dashboard mounts available for them. I'm using a Standard dual band transceiver that is equipped with separate antenna jacks. The vehicle has an antenna for each band for cross-band repeat. These antennas are tuned to resonance and should be as good as possible for operation on either band. As you probably know, satellites are very QRP so a good receive system is quite necessary. It also helps to work only the really high passes and that's where the PDA comes in. The combination of hardware and software makes using the satellites much more enjoyable.

The PocketSat+ program is very good. The small problems with the interface between the program, the Palm utility and the PDA were things that would be expected for an inexperienced computer person like me. However, the work is definitely worth the time and the $25 fee for the registered version is a bargain. It adds a new dimension to satellite fun.

Resouces: http://pocketsat/dataresources.html

Photo 1: Palm Zire 71 running PocketSat+. If you look closely you'll see the AO-51 track.



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